75th ISSUE
APRIL 2026

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ALUMINIUM GDC TECH GREAT DIE CASTING

Contents

Dear Readers,
We always look forward to your Feedback and comments on the Journal. Please do write to us.

Articles for GDCTECH Journal

We invite Expert Articles on technical techno commercial and management aspects of Diecasting Industry, for publishing in GDCTECH Bimonthly Journal. We believe that these articles serve as good source of knowledge for foundry industry people. Please contact GDCTECH office for any further information.

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Note: Some images in some articles may not be clear. Interested readers may contact the author

From the Editor's Desk

Dear Readers,

GDCTECH Journal, 75 issues and counting!! A journey worth remembering…..

More than fourteen years ago, a simple thought took shape, bringing together the diecasting community on a common platform. That idea led to the birth of GDCTECH FORUM, and soon after, the GDCTECH Journal was launched.

The early years were not easy. Publishing a bimonthly technical journal with consistency demanded far more than passion. It required discipline, commitment, and above all, the support of knowledgeable experts willing to share their experience with the industry. For us too, it was a continuous learning process. Looking back today, it is deeply satisfying to realize that we crossed those initial challenges successfully, thanks to the trust and encouragement we received from authors, readers, advertisers, sponsor and the diecasting fraternity at large.

The journal evolved over the years. It became more vibrant in appearance, more professional in presentation and significantly richer in technical content.

In recent years, we took further steps to add greater value for our readers; through focused technical literature series, insightful interviews with experts from foundry and allied fields, and even technical crosswords designed to engage and support younger shop-floor professionals.

About a year ago, we introduced a dedicated section on Magnesium, a metal with promise for the future and strong interest across the diecasting community.

Reaching the 75th issue is therefore not just a number, it is a milestone filled with pride, gratitude and a sense of responsibility. I sincerely thank every contributor who has enriched this journal with knowledge and experience, and every reader who has supported our efforts through the years.

As we move towards April 2026 to publish this issue, the world around us appears suddenly uncertain; war-like situations and supply chain disruptions have created turbulence across industries. Yet, we strongly believe that the diecasting industry, known for its resilience will withstand this phase and emerge stronger, as it always has.

It is our firm belief that GDCTECH Journal will continue to grow alongside the industry, remaining progressive, forward-looking and responsive to the evolving needs of the diecasting community.

With these words and with heartfelt gratitude, on behalf of the Editorial Board, I am pleased to present to you the 75th issue of GDCTECH Journal.

Warm regards,

Anand Joshi

Review of development of Al-Ce casting alloys for high temperature applications in automotive industry

Madhav Athavale, Consultant, athavalemadhav@gmail.com

1 Introduction/Background

Light weighting of cars has been an ongoing activity to improve energy efficiency and reduce environmental impact. Aluminium castings have been increasingly used for power train and body structural components replacing heavier iron and steel components. Images below capture the increasing use of Al castings and growing use of Al in cars.

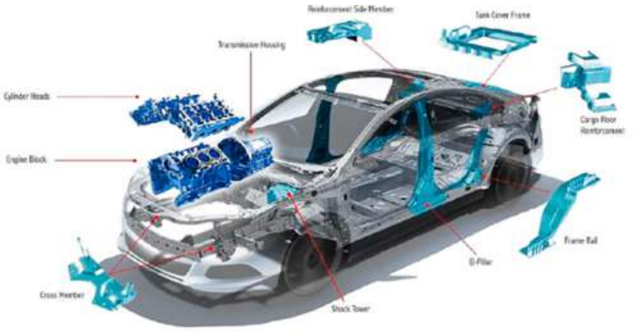
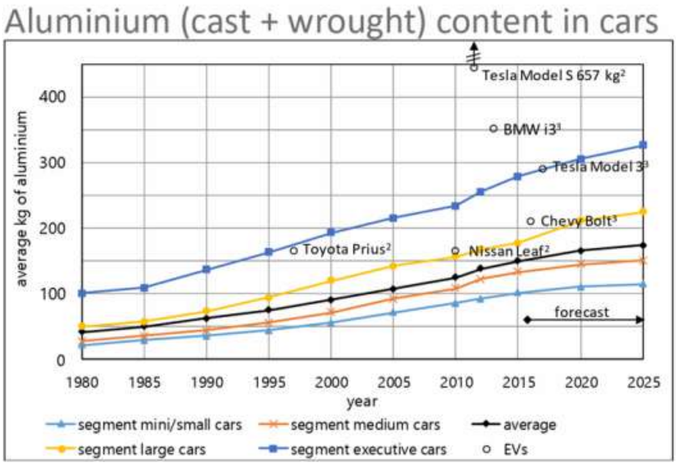
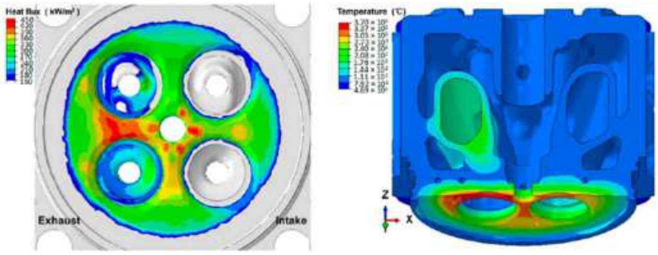


Figure 1. Typical applications of aluminium castings in automotive vehicles [5]. Nemak/American Metal Market Conference, 2015.



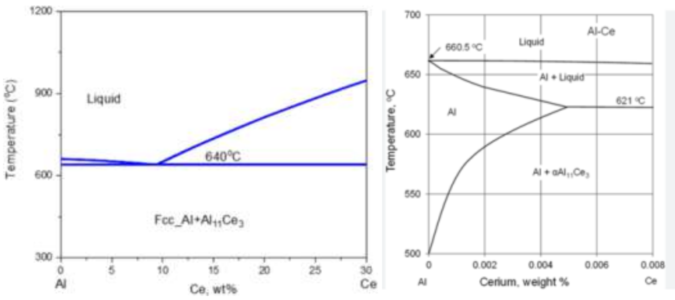
Another important area for light weighting is high powered diesel engines where currently cast irons (grey, S.G. and C.G.) are used for heads and blocks for trucks, military, mining, agricultural, marine engines etc. Switching to Aluminium can result in weight reduction of 40-55% depending on the design and result in associated benefits of lessening of environment impact, improved fuel economy etc. However, use of Aluminium castings in high powered diesel engine heads such as trucks or marine engines has not been feasible due to poor high temperature properties of conventionally used Al alloys around 300 Deg C and high level of peak cylinder pressures that are encountered. Image below shows heat flux and temperature distribution in a marine diesel cylinder head. It is seen that maximum heat flux due to exhaust gases is in the bridge between exhaust valves where temperatures can reach ~ 370 Deg C



This article reviews progress in the development of a new alloy system, Al-Ce-X (X= Mg, Cu, Ni etc.) with the aim of delivering good room temperatures and good high temperatures (~250-300 Deg C).

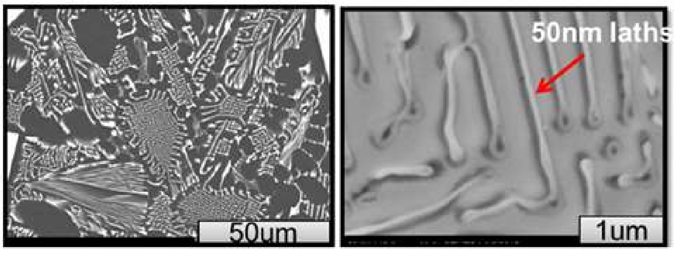
USA Department of Energy funded research work for the development of Al-Ce alloys for use in automotive industry. The work was carried out by Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, Ames National Laboratory and an industry partner Eck Industries of Wisconsin USA. Several research papers have been published. Apart from Al-Ce casting alloys work is being carried out for wrought alloys.

2. Al–Ce-X alloy series development



Above left is the phase diagram of Al-Ce system with Ce up to 30%. It shows eutectic reaction at ~ 10% Ce. Al is primary phase on hypoeutectic side; eutectic has alternate lamellae Al and A11C3 and Al11Ce3 (intermetallic compound) as primary phase on Hyper eutectic side. On the right is the enlarged portion of the diagram clearly showing very low solubility (highest ~0.005%) of Ce in Al. This means on hypoeutectic side primary Al phase will be always very soft as there is no solid solution strengthening like what happens in Al-Si system because of higher solubility of Si in Aluminium.

Typical microstructure of binary Al-Ce alloy showing Al11Ce3 intermetallic.



The as-cast microstructures show a very fine interconnected eutectic microstructure and the pure aluminium phase. The scale of the laths can be as small as 100 nm and do not exhibit preferential direction at standard cooling rates. These structures are stable at higher temperatures. The intermetallic are trapped by the zero solubility of cerium in the aluminium matrix. This trapping prevents the system from minimizing surface energy through diffusion, which blocks the alloys from traditional coarsening interactions.
Following table shows mechanical properties of Al-Ce binary alloys. As may be observed as cast UTS and Yield are moderate compared to conventional Al alloys used by the industry though ductility is excellent in large number of alloys.

	Tensile Mpa, as cast	Yield Mpa, as cast	%*E*, as cast
Al-16Ce	144	68	2.5
Al-12Ce	163	58	13.5
Al-10 Ce	152	50	8
Al-8 Ce	148	40	19
Al-6 Ce	103	30	25

This was recognised in early stages of research and use of Mg, Si, Cu has been explored for improvements in as cast as well as high temperature properties.
2.1 Sims, Zachary et Al in a paper published in 2016 titled "Cerium based intermetallic strengthened Aluminium casting alloy: High volume co product development". It studied Castability & Hot tear as well as microstructure and mechanical property tests with and without heat treatment and reported results of Al-12Ce, Al-12Ce-0.4Mg and Al-12Ce-4Si-0.4Mg alloys. Details of the experiment are given in Annexure 1

Casting of step-plate

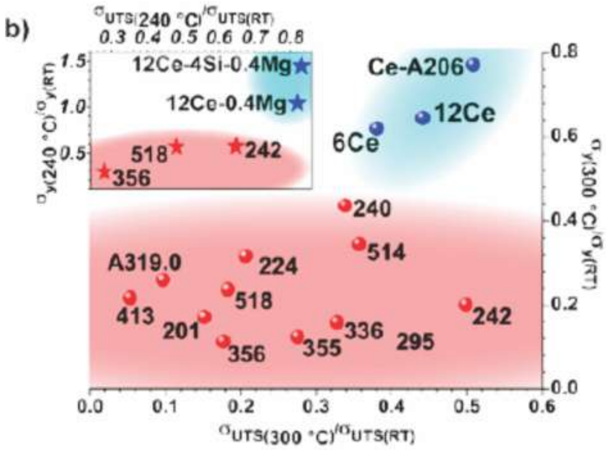
Casting of hot-tear mold

Alloy	As Cast			T6 Treated		
Type	UTS MPa	Yield MPa	Elongation %	UTS MPa	Yield MPa	Elongation %
Al-12 Ce	161.3	57.2	13.5	131.7	47.6	26.5
Al-12 Ce-0.4Mg	200.6	78.6	6.0	224.1	62.1	8.5
Al-12 Ce-4Si-0.4Mg	141.3	75.2	2.0	252.3	128.2	8.5
LM25/A356/Al7Si0.4Mg*	180	90	5.0	310	240	6.0
LM24/A380/Al8Si3Cu1Fe	200	110	2.0			

*For comparison from Handbook

Magnesium is an effective strengthening element for the aluminium matrix. The strengthening is based on the size and modulus misfit of the magnesium in the aluminium which increases the initial yield stress and reduces the dynamic recovery rate of dislocations.

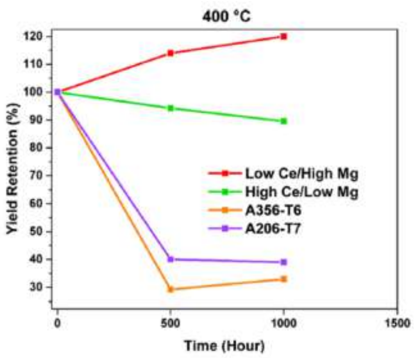
2.2 In 2017 same authors published paper titled " High Performance Aluminum-Cerium Alloys for High-Temperature Applications" that explained microstructural features of Al-12Ce-0.4Mg & Al-12Ce-4Si-0.4Mg alloys and how they show superior High Temperature Strengths to Room Temperature strength ratios than conventional Al casting alloys like A356, A 319, A518 etc.



Ratio of 300° C to room temperature yield strength vs ratio of ultimate tensile strength at 300° C to room temperature, demonstrating superior thermomechanical stability for Al-Ce alloys. Ce-A206 is A206 alloy with 8 wt.% Ce. The inset shows Al-Ce based alloys at 240 °C against standard alloys at 200 °C. Al-Ce-Si-Mg alloys show increased yield at elevated temperature and Al-Ce-Mg shows no decrease relative to room temperature.

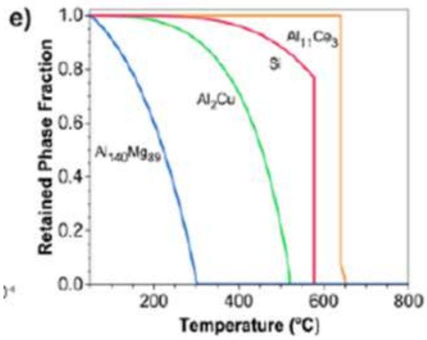
2.4 Paper published in December 2017 by David Weiss titled "Castability and Characteristics of High Cerium Aluminium Alloys" describes a large number of binary as well as ternary Al-Ce alloy studies. In order to evaluate the effect of other alloying elements on the mechanical properties of binary Al-8Ce alloys, another 20 alloys containing Si, Mg, Cu, Zn, Ni, Ti, Mn, or Fe were prepared. However, the mold filling capability was reduced for all alloys when added more than 1 wt%, except with Mg, even though many of the alloys had improved mechanical properties. . The yield strength increased and percentage of elongation decreased with increasing Mg contents for the ternary Al-Ce-Mg alloys. Mold filling ability remained unaffected. Extensive high-temperature mechanical testing has been carried out. The data shown in are the average of six test bars. Details are given in the Annexure 2

2.5 In a January 2019 paper by David Weiss titled "Improved High-Temperature Aluminum Alloys Containing Cerium" following graph compared yield strength retention of conventional alloys and different Al-Ce-X alloys.



High temperature yield strength retention is about three times conventional alloys when tested at 300 Deg C. For Al-Ce alloy systems that use solid solution strengthening elements such as magnesium and/or zinc to improve room temperature strength, room temperature properties do not deteriorate regardless of length of exposure to temperatures of 400 Deg C. The data above show a slight increase in properties, due to homogenization of magnesium in the structure. In these solid solution-strengthened alloys, there are no phases that dissolve or coarsen at that temperature such Mg2Si or Al2Cu.

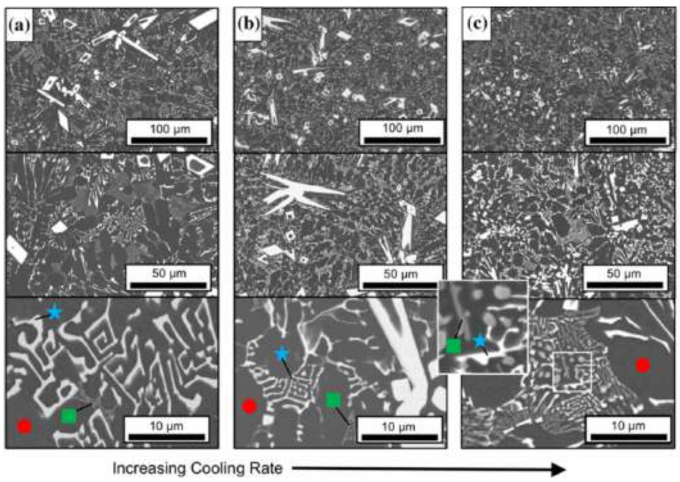
2.6 Mechanism involved in this strength retention: Dissolution of strengthening phases into the aluminium matrix is illustrated in property diagrams below where the fraction of intermetallic precipitates retained decreases with increasing temperature. It is evident that the phase fraction of intermetallic, in this case Al11Ce3, retained at elevated temperatures far exceeds any of the other alloying elements. Colour code: 500-series (blue), 200 series (green), 300 series (red), and the new Al-10Ce (wt.%) alloy (orange).



Conclusion is "The room temperature strength of the Al-Ce alloy family derives from the extremely fine distribution of dendritic intermetallic phases uniformly across the alloy which form during casting. The extremely low solubility of Ce in the solid Al matrix favours retention of this structure to extremely elevated temperatures compared to traditional casting Al alloys, and this is reflected in the superior retention of mechanical properties to above 300°C. These features lead to complex load-sharing in the binary Al-Ce alloy, where slight Mg addition markedly improves the material strength and offers a guide to further improvements in this new class of Al alloys."

3.0 Wedge mould study and Production of a test casting in an industrial production setup

Wedge mold study was coducted by Eric Stromme et al to understand the effect of changing the high solidification rate on Al-Ce-based alloys.



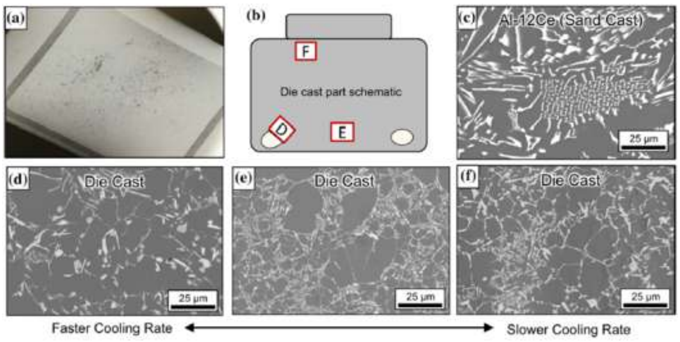
SEM backscatter images from three points within Al-12Ce-0.4Mg-1Fe wedge mold samples: (a) slowest, (b) moderate, and (c) highest cooling rate. Three magnifications are shown for each location.

Al-8Ce-0.4Mg, Al-12Ce-0.4Mg, and Al-8Ce-8Mg, along with the same three compositions with 1% Fe added (all percentages by weight, with remainder Al). The molten alloys were injection cast into a Cu mold that has a rectangular opening of 5 X 10 mm and a depth of 35 mm (where the 5 mm width narrows to 0 mm)

Al-Ce-based alloy microstructures consist primarily of an Al matrix and a binary intermetallic Al11Ce3 that forms by a eutectic reaction upon solidification. Here, Mg is preferentially absorbed into the Al metal matrix (marked with a red circle) while Al11Ce3 intermetallic (blue star) forms and strengthens the material. The addition of 1% Fe introduces another component to the eutectic microstructure (green square).

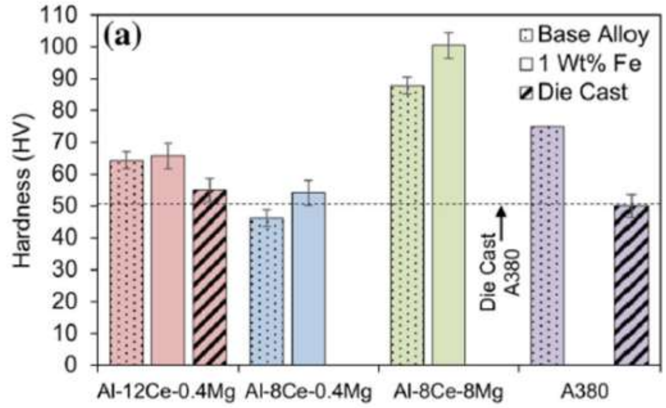
HPDC Trials with Al-12Ce-0.4Mg-1Fe alloy

For the industrial-scale die cast trial, 1800 kg of Al-12Ce-0.4Mg-1Fe alloy was produced and poured into ingots. These ingots were shipped to the die cast foundry, melted down, degassed, and prepared for production runs. The die casting trial utilized a 600-ton die cast machine and a die used for process development and qualification. The part consisted of a flat plate with holes at the corners and a curved vertical surface on one side. As a result, the cooling rate varied across the mold with the highest rate near the edge of the plate and near the holes. The cooling rate at the connection to the vertical surface was the lowest. The cooling rates during die casting are estimated to be between 15 K/s and 115 K/s.



(a) X-ray radiograph of die cast plate, showing low defect density. (b) Schematic of die cast part with locations of SEM backscatter images. (c) A SEM backscatter image of a typical sand cast microstructure of Al-12Ce binary. (d–f) SEM backscatter images (from fastest to slowest cooling rates, respectively) on the die cast 12Ce-1Fe-0.4Mg part.

Hardness measurements on wedge and die casting



Vickers hardness measurements of wedge mold samples for different compositions with and without 1%Fe, Al-12Ce-0.4Mg-1Fe in die cast condition, and industry standard A380 in typical and die cast condition.

One can observe that Hardness values for die cast , Al-12Ce-0.4Mg-1Fe and industry standard A380 alloy are similar. Usually, Hardness and UTS have a linear relationship in metals. The Al-12Ce-0.4Mg-1Fe alloy exhibited good fluidity and no major casting defects at comparable settings used for A380 with a _ 10 K increase in melt temperature. The fill shot time was increased by approximately 0.25 s to accommodate for turbulence issues associated with the higher fluidity of the alloy.

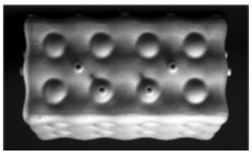
4.0 General production methods for Al Ce alloy castings

As per David Weiss, general production systems used for melting, de-gassing and other processing of aluminium-silicon or aluminium-copper alloys can be used without modification for casting of aluminium-cerium alloys. Sand, gravity die, low pressure die and high pressure die casting processes have been used successfully for casting aluminium cerium alloys. As more experience is gained in making the castings, these processes may be appropriately modified to minimise casting defects and process improvements.

Given below are few examples-

(i) Gravity die cast general aviation air cooled cylinder head casting in Al-Ce binary alloy

(ii) Low pressure precision sand cast 21X12X17.5’’ conformal storage tank cast from Al-Ce-Mg alloy.



(iii) Air-cooled cylinder head cast in Al-12Ce-0.4Mg

5.0 Economics of Ce and Al-Ce Alloys :

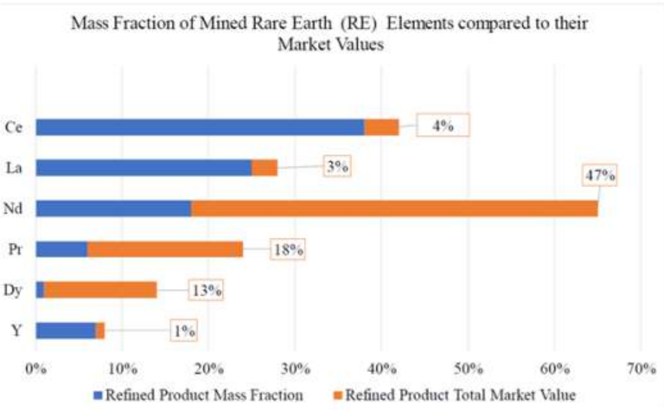
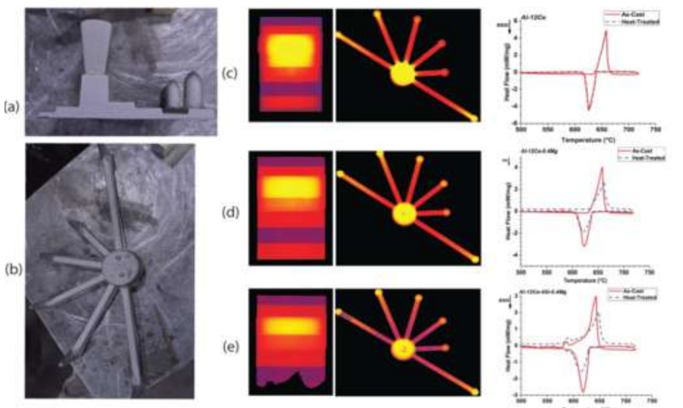


Figure 2.3-1: Mass fraction of RE mined compared to gross market value modified and adapted from [25], and the data is taken from [84]–[86].

In 2020, CeO2, the main oxide demand for Ce extraction, was $1.50/kg. High value RE oxides such as Pr, Nd, and Dy cost $60/kg, $47/kg, and $258/kg, respectively. Cerium is the most abundant rare earth. As of mid-March 2026, price of metallic cerium is $3.5/kg ex China . The use of cerium as an alloying element is economically feasible for high-volume production. The as-alloyed cost of Al-Ce material is competitive with other high-performance aluminium alloy systems. The sensitivity currently is controls over export by China. Many other countries including India are now pushing for increasing the production of Cerium as well as critical rare earth minerals.

6.0 Conclusion

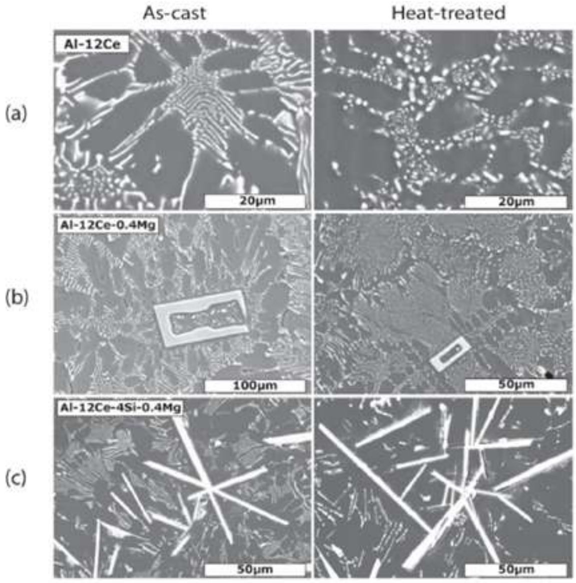
To meet the needs of light weighting of high-powered diesel engine castings used in trucks, mining, marine applications Iron castings are sought to be replaced by aluminium alloy. However conventional A356 or A319 alloys currently used by the automotive industry for car I.C. engine head castings do not exhibit adequate high temperature (250-300 Deg C) mechanical properties. After 10 years of research funded by United States Department Energy, a new alloy system has been developed that uses the abundant rare earth element Ce as the primary alloying element. Technology has been licenced to Eck Industries, Manitowoc, WI, USA who are offering casting as well as wrought alloys since last few years. These alloys have good casting and forming characteristics along with better corrosion performance than most aluminium alloys. Performance at high temperatures with prolonged exposure times is better than most aluminium alloys. These attributes combined with affordable prices make the Al-Ce system useful for lightweight high-performance applications in the automotive, trucking, aerospace and other industrial sectors. Review paper has covered some initial casting applications however lot more needs to be done by the inventors and designers by way of design, production and testing of actual truck diesel engine cylinder head castings in lab and field for their performance before the large-scale adoption takes place. Successful adoption of these alloys will bring significant environmental and economic benefits by way of reduced carbon foot print, gainful use of currently wasted Ce bearing ore associated with other more valuable RE elements needed for electric motors and wind power equipment. Estimates of economic impacts have been done through various studies funded by United States Department of energy.



(a) Casting of step-plate used in castability assessment (b) Casting of hot-tear mold used in castability assessment. (c) Low-energy X-Ray color maps of Al-12Ce hot-tear and step-plate molds with DSC curves. (d) Low-energy X-Ray color maps of Al-12Ce-0.4Mg hot-tear and step-plate molds with DSC curves. (e) Low-energy X-Ray color maps of Al-12Ce-4Si-0.4Mg hot-tear and step-plate molds with DSC curves.

It is observed that Al-12Ce and Al-12Ce-0.4Mg exhibited excellent fluidity and no tendency for hot tear. Al-12Ce-4Si-0.4Mg had poor fluidity.

Microstructure



a) In the case of the binary Al-12Ce alloy (figure 3a),two phases are present; aluminum metal(gray) and the binary intermetallic Al11Ce3 (white). The binary intermetallic, in the as-cast state, is characterized by a highly interconnected eutectic microstructure.

b) The ternary Al-12Ce-0.4Mg alloy is shown in figure 3b. In the as-cast state there are primary crystals of Al11Ce3 consisting of large rectangular grains. This is a clear difference between the binary and ternary alloys. Mg suppresses the undercooling characteristics of the rapid solidification and force primary solidification.

c) Al-12Ce-4Si-0.4Mg alloy is a multiphase system. There exist in the as-cast state, three phases. The smallest is AlSiMg accounting for under 2 wt%. The main two phases present are the aluminium (FCC) phase and the intermetallic Al11Ce3, both reflected in figure 3c. Al11Ce3 shows both primary and eutectic solidification in the as-cast state. The silicon not accounted for in AlSiMg is dissolved in the aluminium matrix. Following the T6 heat-treatment, a new phase precipitates. The new phase is a ternary intermetallic, AlCeSi. During heat-treatment the new ternary phase consumes the eutectic growth and transforms the present primary crystals to AlCeSi.

Mechanical Properties

Alloy	As Cast			T6 Treated		
Type	UTS MPa	Yield MPa	Elongation%	UTS MPa	Yield MPa	Elongation%
Al-12 Ce	161.3	57.2	13.5	131.7	47.6	26.5
Al-12 Ce-0.4Mg	200.6	78.6	6.0	224.1	62.1	8.5
Al-12 Ce-4Si-0.4Mg	141.3	75.2	2.0	252.3	128.2	8.5
LM25/A356/Al7Si0.4Mg	180	90	5.0	310	240	6.0

Trial Castings

Air-cooled cylinder head cast form Al-12Ce-0.4Mg

Air-cooled cylinder head cast from Al-12Ce

Annexure 2

Castability and Characteristics of High Cerium Aluminium Alloys

Table 2. As-cast mechanical properties (MPa) of binary compositions in the Al-Ce system.

	Tensile, as Cast	Yield, as Cast	% E, as Cast
Al-16Ce	144	68	2.5
Al-12Ce	163	58	13.5
Al-10Ce	152	Test Error	8
Al-8Ce	148	Test Error	19
Al-6Ce	103	30	25
443 (Al-5Si)	145	40	2.5

Table 3. As-cast mechanical properties (MPa) of ternary compositions in the Al-Ce system.

	Tensile	Yield	% E
Al-8Ce-4 Mg	189	107	3
Al-8Ce-7 Mg	195	151	2
Al-8Ce-10 Mg	227	186	1

Table 4. Elevated temperature properties (MPa) of Al-8Ce-10 Mg.

	Temp	Time (h)	Tensile	Yield	% E	
Al-8Ce-10 Mg	260°C	0.5	137	130	4	
	260°C	336	137	97	5	
	315°C	0.5	97	55	20	
	315°C	216	172	159	1	Tested at 25°C
	260°C	336	159	138	1	Tested at 25°C

It was noted that room temperature properties were better after long-term exposure at 315°C than at 260°C. This indicates some positive effects from long-term exposure at high temperatures. Thermal treatments have been investigated to improve room temperature mechanical properties.

References

1 Development and Characterization of a Novel Near-Eutectic Al-Ce Alloy with Additions of Ni and Mn for Elevated Temperature Applications in the Automotive Industry by Jordan Roger Kozakevich B.A.Sc., The University of British Columbia, Okanagan, 2020

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF APPLIED SCIENCE in THE COLLEGE OF GRADUATE STUDIES (Mechanical Engineering)

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Following are reports for the projects funded by U.S. Department of Energy

#2 CERIUM BASED INTERMETALLIC STRENGTHENED ALUMINUM CASTING ALLOY: HIGH VOLUME CO-PRODUCT DEVELOPMENT by Sims, Zachary C. 1 ; D.Weiss2; SK McCall3;MA McGuire1; RT Ot4; Geer, Tom1; Rios, Orlando1 from 1 – Oak Ridge National Laboratory, Oak Ridge Tennessee, USA. 2. Eck Industries, Manitowoc, Wisconsin, USA 3—Lawrence Livermore National Laboratory. Livermore, California, USA. 4-- Ames National Laboratory, Ames, Iowa, USA. May 2016

#3 High Performance Aluminum-Cerium Alloys for High-Temperature Applications by Zachary C Sims1, O.R. Rios1*, David Weiss2 , P.E.A. Turchi3 , A. Perron3, Jonathan R.I. Lee3 , Li T. Tian3, Joshua A. Hammons3, Michael Bagge-Hansen3, Trevor M. Willey3, K. An1, Yan Chen1, A.H. King4, S.K. McCall3* from 1 Oak Ridge National Laboratory, 2 Eck Industries, 3 Lawrence Livermore National Laboratory, 4 Ames Laboratory, *corresponding authors August 2017

#4 Castability and Characteristics of High Cerium Aluminium Alloys Written By David Weiss, Published: 22 December 2017 DOI: 10.5772/intechopen.72830

#5 Ageless Aluminum-Cerium-Based Alloys in High Volume Die Casting for Improved Energy Efficiency by Eric Stromme1, Hunter B. Henderson3, Zachary C. Sims2, Michael S. Kesler3, David Weiss4, Ryan Ott5, Fanquiang Meng5, Sam Kassoumeh6, James Evangelista6, Gerald Begley7, Orlando Rios3 from 1United States Navy, 2University of Tennessee, 3Oak Ridge National Laboratory, 4Eck Industries, Inc., 5Ames Laboratory, 6Shiloh Industries, Inc., 7Tennessee Tool and Engineering, Inc.Corresponding Author: Orlando Rios, rioso@ornl.gov April 2018

#6 The Efficacy of Replacing Metallic Cerium in Aluminum-Cerium Alloys with LREE Mischmetal Zachary Sims*1; David Weiss2; Orlando Rios3; Hunter Henderson3; Michael Kesler3; Scott K. McCall4; Michael Thompson1; Aurelien Perron4, Emily Moore4 from 1University of Tennessee, Knoxville, TN; 2Eck Industries, Manitowoc, WI; 3Oak Ridge National Laboratory, Oak Ridge, TN; 4Lawrence Livermore National Laboratory, Livermore CA *Corresponding Author

7 Improved High-Temperature Aluminum Alloys Containing Cerium by David Weiss (Submitted August 7, 2018; in revised form January 3, 2019; published online February 1, 2019), Journal of Materials Engineering and Performance

8 Composites and Alloys Based on the Al-Ce System by David Weiss Submitted: 29 October 2018 Reviewed: 01 October 2019 Published: 23 November 2019, Open access peer reviewed chapter, Book "Aluminium Alloys and Composites" DOI: 10.5772/ intechopen.89994

9 Solidification processing of Al-Ce Alloys for High temperature Applications by Shimaa Al Haddad1,Mohamed Issa Mussa1,Adel Nofal1, Eric Reidel2 from 1 Central Metallurgical Research Institute, Helwan, P.O.Box 87,Egypt 2 Institute of Manufacturing Technology and Quality Management, Otto-von-Guericke-University, Universitatsplatz, 39106, Magdeburg, Germany, Presented at 15th International Aluminium Conference, Qubec, QC, Canada 11-13 October 2023

10 Recent progress in Creep-Resistant Aluminium Alloys for diesel engine applications : A review by Raul Irving Arriaga-Benitez and Mihriban Pekguleryuz, Department of Mining and Materials Engineering, McGill University, Montreal, Canada Published on 22 June 2024 in Materials 2024

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8th International Women's Day

7th (Saturday) March 2026 | Hotel President, Pune 04

UPDATE

International Women's Day Celebration – "Give to Gain"

As part of the International Women's Day celebrations, the GDC Tech Forum & ASM International Pune Chapter jointly organized Women's Day celebration.

Mr. Anil Kulkarni, President the Chief Guest, Panellists, Invitees, Members of GDCTECH & ASM Pune Chapter. In his welcome address to introduce the importance & objective of the IWD. Ms. Swathi Ramesh in her Keynote address narrated her experience of career growth, not only by the guidance of her father Mr. Ramesh & colleagues in the factory. Main contributor for her growth was developing the co-cordial relationship with people on the shop floor to understand their pain areas and thinking on solutions. Which was a good learning point and gaining the confidence of the shop floor people and enhancing my technical capability capacity. The panel discussion moderated by Ruta Barve, Secretary of the ASM Pune Chapter and Founder of Mettle Consultancy Services. The discussion explored how personal commitment, professional investment, and collective support contribute to both individual growth and industry advancement.

Distinguished Panelists

The distinguished panelists included:

Aishwarya Jadhav, Business Associate at Machine Tech, with experience in foundry operations and manufacturing management. Dr. Manisha Kulthe, Head of the Department of Metallurgy and Materials Engineering at COEP Technological University, Pune, with extensive experience in teaching, research, and academic leadership in materials science. Meha Shah, Business Development Executive at Sipra Engineers Pvt. Ltd., representing the new generation of professionals engaged in global engineering business development. Sayali Hitesh Patil, Senior Manager – Operations at Machine Tech, with expertise in financial planning, MIS, and international operations. Swati Jagtap, Head of Operations at Assertive Industries LLP, bringing over 16 years of industrial experience in wiring harness manufacturing and die casting operations.

Discussion Highlights

The conversation was structured around the central idea that giving—through effort, knowledge sharing, mentorship, and support—creates opportunities for growth and collective progress. Panelists reflected on their early career experiences and the investments they made in building technical credibility in traditionally male-dominated industrial environments. They shared how persistence, continuous learning, and the willingness to take on challenging responsibilities helped them gain professional confidence and recognition. The discussion also explored the evolving role of women in metallurgy, die casting, and manufacturing industries. Panelists emphasized the importance of mentorship, supportive workplace cultures, and inclusive leadership in enabling more women to pursue and sustain careers in engineering and manufacturing. A particularly engaging segment of the discussion connected the theme "Give to Gain" to metallurgical processes, with panelists drawing parallels between professional growth and processes such as forging, heat treatment, and alloying - where transformation occurs through deliberate input of energy, effort, and time. The panel concluded with a shared reflection that when individuals and organizations consciously invest in supporting women's growth, the benefits extend beyond individuals to strengthen teams, industries, and Communities. The session served as an inspiring reminder that giving - whether through knowledge, opportunity, or encouragement - is not a subtraction but a multiplier for progress.

Mr. R.T. Kulkarni, Founder, GDCTECH presented the appreciation mementos to the Chief Guest and Panelists.
Mr. D.G. Chivate, President, ASM Pune Chapter, proposed the vote of thanks.The entire programme ended with Dinner.

7 Golden Practical Rules of Aluminium HPDC

C. Surianarayanan - Consultant, Email : c.surianarayanan@gmail.com

1. Die Temperature Stability is More Important than Machine Settings

If the die temperature fluctuates:

- Filling pattern changes
- Porosity pattern shifts
- Dimensions drift

Golden rule:
Stabilize die temperature first, then adjust process parameters.

2. Metal Should Flow — Not Splash

When the metal in the shot sleeve splashes:

- Oxide films form
- Air entrapment increases
- Porosity becomes unavoidable

Golden rule:
Maintain proper **fill ratio and slow shot control** so the metal front moves smoothly.

3. Gate Velocity Must Match Wall Thickness

Many engineers increase velocity blindly.
Better approach:

- Thin sections → higher velocity
- Thick sections → moderate velocity

Golden rule:
Gate velocity should be **just enough to fill before freezing**, not the maximum the machine can give.

4. Intensification Pressure Cannot Fix a Bad Filling Pattern

A common mistake in plants is:
"Porosity → increase intensification pressure."
But if air is trapped during filling, pressure will only **compress the gas bubble**, not eliminate it.

Golden rule:
Good filling pattern first, pressure later.

5. Venting and Overflow Decide Casting Quality

Many dies fail because:

- Air has **no escape path**
- Overflows are too small or wrongly located

Golden rule:
Metal should push air towards vents and overflows, not trap it inside the cavity.

6. Die Lubrication is a Thermal Control Tool

Lubricant is not only for release.
It also:

- Controls die temperature
- Prevents soldering
- Maintains surface finish

Too much spray → die cooling
Too little spray → die sticking.

Golden rule:
Spray should maintain thermal balance, not just release the casting.

7. Stable Process is Better than Fast Cycle Time

Many plants chase **short cycle times**, which causes:

- Thermal imbalance
- Die cracking
- Porosity variation
-

Golden rule:
A stable 40-second cycle is better than an unstable **32-second cycle.**

One more unwritten truth

After many years in die casting, experienced engineers realize:
"Most casting problems are not machine problems — they are **thermal balance problems."**

Family Business

Vishwas Kale, Managing Director, Vijayesh Instruments Pvt Ltd
sales@vijayesh.net

Indian business has a history of family owned businesses. Such family business has been in practice since long, but changing its nature and structure over the times.

Earlier, trading and money lending was done in bazaars through shops, owned and confined to a few communities.

Large corporate business houses are still controlled by the respective families. Here the role of family patriarch is very critical and respected. This is somewhat similar to the Emperor Model in a family business. Family owned businesses continue to grow and they are a big part of the society. These also form the backbone of our economy and social related growth.

No doubt, the family owned businesses do face challenges. But they have many times shown better performances than public and multinational companies by finding solutions to overcome the limitations and also strong survival. It may not be incorrect to say that the financial performance of family owned businesses is much better than the non-family owned businesses. These include growth in revenue, gross margins, and earnings before interest, tax depreciation, reserves etc.

Most large family businesses were born post-independence and during the economic reforms of the 1980s-1990s. The businesses are still young. However, they are fast changing the way of control and management. These families are concerned about wealth creation and protection, social status, family reputation. To achieve this and for sustenance, self-discipline and self- management is high, leading to sound business base and good monitoring of it. Family constitution have a big role in keeping the family together and aligned.

Indian families have traditionally a large emotional connect along with business aspirations. The commitment and passion for the business is outstanding. The next generation does get involved and participate in the business with a more progressive and energetic outlook. The older family members feel delighted when along with business expansion, wealth creation is created with the support of the next generation.

What are the challenges for family businesses?

Family businesses can no longer work to operate with old traditions and methodologies. It is necessary to change the traditional mind-sets. The era of disruptive technologies and digitization should be accepted.

The decision-making is influenced by multiple generations of a family, related by blood or marriage or adoption, who has both the ability to influence the business and strategic decisions. Effectiveness and existence of family business is decided by the mutual understanding persisting within the family. There could be problems if family business is comprised of more than one family in operations. Family members who are not contributing or not involved in business are also influential and could pose a problem. Sibling rivalry is an important issue. Conducting family meeting on regular basis will help establish and keep the family focused on rules, goals and objective. Separating business from personal emotions is vital. An incorrect approach, like elder person of the family to empower to frame rules and control business activity, which is many a times followed is not correct.

It is noted that the methodology in such businesses has changed for its own survival. Due to the increase in the business size, the business families found it difficult to manage the operations and mobilize resources necessary for continuity. Therefore, the financial control of the businesses is gradually moving from the promoters to the finance providers.

Family businesses have now a necessity to have a good balance between profits and family relationships. Ownership and having professionalization with great transparency is very challenging. A few things like lack of communication between family members, tight control by the family patriarch, no written or agreed family policies can become problematic to the business. This does hamper the career growth of the family members and the employees.

Most business founders sadly find themselves at the brink of retirement with no planned succession. It could be within the family or from outside. Many family CEOs do not make a formal retirement plan. This has led to troublesome relationships, bad or delayed decision-making within the family. Many business families have decided or separated and partitioned for internal peace within the family and better management control. Of these, some succeeded and branched out bigger and better, while some failed and collapsed totally. We see that family businesses are splitting quite rapidly.

It is observed that in medium to large size businesses, professionals are employed to run the business on day-to-day basis under the Board of Directors. The good governance creates a good business brand and gives better results. The pre-selection process of a CEO is about separating ownership from management, and the goal is to objectively select the candidate without letting emotions get in the way. Finally, once the family chooses a candidate, it must give the new executive the autonomy to create a new strategy. The family can guide the new manager, but independence is essential.

It is important that a business is able to stay with the latest trends. Family businesses can become insular and entrenched in their ways, so an external professional can help ensure that the business model stays current.

The decision to bring an external professional is not easily acceptable for family businesses. There can be a degree of distrust, some family members worry about losing control of business that has been internally controlled for years. The cultural shock has to be accepted. Initially, there can be unreasonable expectations heaped upon the new executive. The professional can lead only if the family lets them be independent and relationship between promoter and executive is such that both are open to each other's advice.

But these obstacles, while arduous, are not insurmountable. And the results can be quite positive for the business, resulting in an external executive who brings a smart perspective on operations, wide-reaching personal connections and valuable global experience.

Today, the next generation is well educated, having global exposure. They are trained for professionally managing the business. This creates base for continuity and creating a brand. Now family businesses are accepting professionals on board. The professional help is sought on family constitutions, roles and responsibilities. Also addressed are performance driven rewards and recognitions for the employees and family. Today participation is encouraged at all levels without any gender bias. The days of family business are bright and shiny.

Hearty Congratulation

Equismart and Bolion Partner to Deliver Advanced Automation Solutions for Aluminium Die Casting in India

Founder Rohit Ramchandani & Founder Cuibiao Chen

[Mumbai, India 6th March 2026]

Equismart Technologies , India and Bolion Automation Equipment Co. Ltd, China have officially partnered to jointly develop and supply advanced automation solutions for the aluminium die casting industry in India. This strategic collaboration will focus on delivering integrated solutions including DCM automation systems, cutting machines, saw stations and deburring machines.

Nitin Bhagwat
Chairman & M.D.
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Davos Experience: A talk with Mr. Nitin Bhagwat

Pramod Gajare, Quality Consultant,
pramodgajare2013@gmail.com

Pramod Gajare
Consultant

Mr. Nitin Bhagwat is the first-generation entrepreneur. He is Chairman and Managing Director of Noble Cast Comp. Pvt Ltd. Pune From a middle-class family to building an export-oriented company his journey is fascinating. After quitting a job, in 2004 he started this venture with capital of mere 25 Lacs. From that tiny foundry it has now grown to a multi-location enterprise with 4 plants in pune & one in USA Company and exporting to USA, Europe, Germany, Italy, Greece and Australia. He is also engaged in various social activities. Currently he is shouldering a responsibility of a Treasurer of GDCTech Forum.

Pramod Gajare: At the start, please accept our greetings, as you were felicitated at Davos by Mr. Devendra Fadanvis, Chief Minister of Maharashtra. Please tell us more about it.

Nitin Bhagwat: I attended the Global Impact Forum Conference organised by Sakal Media Group at Davos, where many MSME entrepreneurs from Maharashtra were present. During the event, MSME leaders and some eminent personalities were honoured for their contribution to industry and employment. Hon'ble Chief Minister Mr. Devendra Fadnavis said that MSMEs are the backbone of the Indian economy and create large employment opportunities. I was honoured as part of this initiative for my work in the manufacturing sector.

PG: Great. This's really a matter of honour. This will definitely inspire the people in MSME sector of industry. Going ahead, will you please elaborate a little about Davos? What is it famous for globally?

NB: Davos is a small mountain town in Switzerland. Even though it is a small place, it becomes a global meeting point every year where powerful leaders come together to discuss how to make the future of the world better. The World Economic Forum (WEF) is a Swiss non-profit organization started in 1971 by Professor Klaus Schwab. It was first called the European Management Forum and later became the World Economic Forum as its vision grew globally.
Every year in the month of January, global leaders from business, government, and society meet in Davos for the Annual Meeting. They talk about important world issues like economic growth, jobs, trade, technology and artificial intelligence, climate change, clean energy, global health, inequality, and the future of work.
The main aim of these discussions is to help countries and industries work together to build a stable, sustainable, and better future for everyone.

PG: It's interesting to know and understand. When we visit some place, may be an exhibition, conference of symposium we have some goal in mind. You must have had some target or purpose for this visit. What was the purpose of your visit to Davos?

NB: I visited Davos to upgrade myself and expand my global business vision. My journey started as an employee and technocrat, then I became a first-generation entrepreneur, and today I think more as a businessman focused on growth, strategy, and new opportunities. The purpose of this visit was to understand how global businesses think, how world leaders make decisions, and to gain inspiration to think bigger beyond technical boundaries.

PG: How can someone participate in Davos? Is an invitation required, or can anyone join?

NB: Participation in Davos happens at two levels.

General access allows people worldwide to watch sessions online and learn from global leaders discussing the economy, technology, and future challenges. Paid or invited participation is reserved for top business and government leaders, involving high-level meetings and global networking. The World Economic Forum membership can range roughly from CHF 60,000 to CHF 600,000 per year, which is approximately ₹70 lakh to ₹7 crore+, and the Annual Meeting participation fee of about CHF 20,000–25,000 is roughly ₹23 lakh to ₹30 lakh,

In simple terms - Davos is where the world comes not only to discuss ideas, but also to shape the future together.

PG: At Davos, we heard about investment 'MoU's worth lakhs of crores for Maharashtra. How much of these announcements are realistic, and how many actually turn into real projects?

NB: I had the opportunity to attend an interaction of Maharashtra's Hon'ble Chief Minister, Shree Devendra Fadnavis, where he explained the details of these 'MoU's and foreign direct investment (FDI). He also clarified that 'MoU's are expressions of intent — they indicate planned investments over the next 5 to 10 years and do not always convert fully into actual projects. In general, around 20–30% of 'MoU's typically materialize on the ground; however, Maharashtra has historically achieved a higher conversion rate, reportedly close to 70%, due to strong industrial policies and infrastructure support. At the same time, some proposed projects may be delayed or cancelled because of local challenges, approvals, or market conditions.

PG: What was your most valuable learning and experience from this Davos trip?

My most valuable learning from the Davos visit was how much my vision expanded by seeing and interacting with eminent global leaders and understanding how the world is thinking about the future. Visiting the Maharashtra Pavilion as well as pavilions of other countries gave me a practical view of how investment 'MoU's and global collaborations actually take shape. I also attended open World Economic Forum sessions, where I gained insights into future trends — from artificial intelligence to social challenges. One discussion that stayed with me was about reducing children's screen time by developing AI solutions that work without constant visual exposure.

Listening to Maharashtra's Hon'ble Chief Minister, Shree Devendra Fadnavis, was another inspiring experience. His vision of building a one-trillion-dollar Maharashtra economy by 2030, along with the bold steps being taken to achieve it, reflected strong leadership, energy, and deep commitment toward the state's progress.

Beyond knowledge, this journey helped me build meaningful relationships and connect with many new business leaders and professionals from India and across the world. Overall, the visit broadened my perspective, strengthened my global outlook, and motivated me to think bigger for the future.

PG: It must have been a delighting experience. Since you are exporting to many countries, are dealing with many overseas companies; for the benefit of the readers of GDCTech Journal please share your views about how global customers look at India for sourcing?

NB: Today, global customers look at India as a trusted and growing manufacturing partner. They appreciate India's strong engineering talent, skilled workforce, and ability to offer good quality at competitive cost. Many companies also see India as a stable alternative for long-term sourcing and supply chain diversification. At the same time, global buyers expect consistency in quality, timely delivery, transparency, and professional communication.

PG: As we are heading towards end of the discussions, this is a last question for you. Post pandemic the world has changed a lot and is passing through a turbulent phase. In this volatile Geopolitical situation, what should be the prime focus of Indian founders to sustain and expand the business?

NB: In the current volatile geopolitical situation, Indian founders should focus on consistent quality, strong supply chains, cost control, and diversification of markets. Investing in technology and maintaining a global mindset will help manufacturers sustain and grow.

PG: A very meaningful advice! The readers of GDCTech journal will be delighted to read your experience at Davos and understand your views.

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94th COFFEE TALK

"IF BUDGETS MADE MONEY, EVERYONE WOULD BE PROFITABLE"

(How to Prepare and Implement Budgets Beyond Paper & Excel)

Saturday, 31st January 2026 at MCCIA, Bhosari, Pune - 411026

Distinguished speaker:
CMA Shri. Anand Karwa

About the event:

The topic received very enthusiastic response. Our speaker Shri. Anand Karwa was an extremely experienced person in finance, with 30 years of experience around the globe. Anand Ji worked with Tata, Infosys, Cummins India, Cummins USA, Arvind Mills, Opus; the list goes on... At present, he is a Founder & Director of AM Square Partners Pvt. Ltd. - a finance and strategy advisor, serving from large enterprises to start-ups.

The Coffee-TALK gave a better sense of the What, When, Why, Where, Who and How of Budgeting. It helped getting our arms around the common problems related to budgeting as a tool for business management, rather than an academic exercise. What are the common causes of Budgets Failing? Are they too rigid, too ambitious, non futuristic? What is Starting Point of a Good Budget? These and many more questions were answered by Shri. Anand Karwa. He moved everyone from Ignorance to Acceptance. Made everyone to understand the need of a good budget.

We had an audience of around 40. Owners/Promoters of Foundries, related MSMEs, Management Team, CFOs, & Heads of Departments attended the talk. "Coffee-TALK" is on 4th Saturday of every month. See you at the next Coffee-TALK !

95th COFFEE TALK

THE ART OF DESIGNING KPIs

28th February 2026 at MCCIA, Bhosari, Pune - 411026

Distinguished speaker:
Shri. Rupesh Harkut, Management Consultant

About the event:

Being a coffee talk of the month of February, we wanted to select the topic which becomes helpful for companies in settingup goals for the upcoming financial year. All companies now-a-days design KPIs to align company's goals with individual employees' goals. Hence we selected this most relevant topic for February's coffee talk, "an art of designing KPIs". Definitely this topic was going to help the industry in setting up their goals for the upcoming financial year. Our speaker Mr. Rupesh ji harkut is an excellent consultant in this field. With an experience of more than 25 years, Rupesh Ji had a vast knowledge regarding goal settings and difficulties in achieving. The invitation was well received by all GDCTECH's members. The seminar hall was overwhelmed with attendance. Rupesh ji touched many aspects of setting KPIs. Right from defining the basic terms, to handling the interaction between different departments.

Question answer session was also very informative.

All-in-all, success of this Coffee-TALK showed industry's willingness to learn new things. GDCTECH's CoffeeTALK team will keep on arranging such useful sessions in future.

The Invisible Advantage:
Digital Radiography as India's Gateway to Sustainable Aluminium Die Casting

Karthikeyan Jawahar, Director, KARMA INNOVATION, karthikeyan.j@karmainnovations.com

ABOUT THE AUTHOR

Mr. Karthikeyan Jawahar, BE, MBA, Six Sigma Black Belt, CPPM (IIM Indore), CFP
Director, Karma Innovations and Solutions Pvt Ltd
His research on Digital Radiography was funded by the Government of India, and he was incubated at TREC-STEP, NIT Trichy. With over 22 years of hands-on experience in industrial radiography, digital imaging systems, and non-destructive testing, Karthikeyan has led implementation projects at more than 70 die casting and foundry facilities across India. Along with Mr.Malaravan, Director, Team Karma, bridges the gap between high-performance quality inspection and practical, sustainable, cost-effective manufacturing for the automobile and electrical industries.

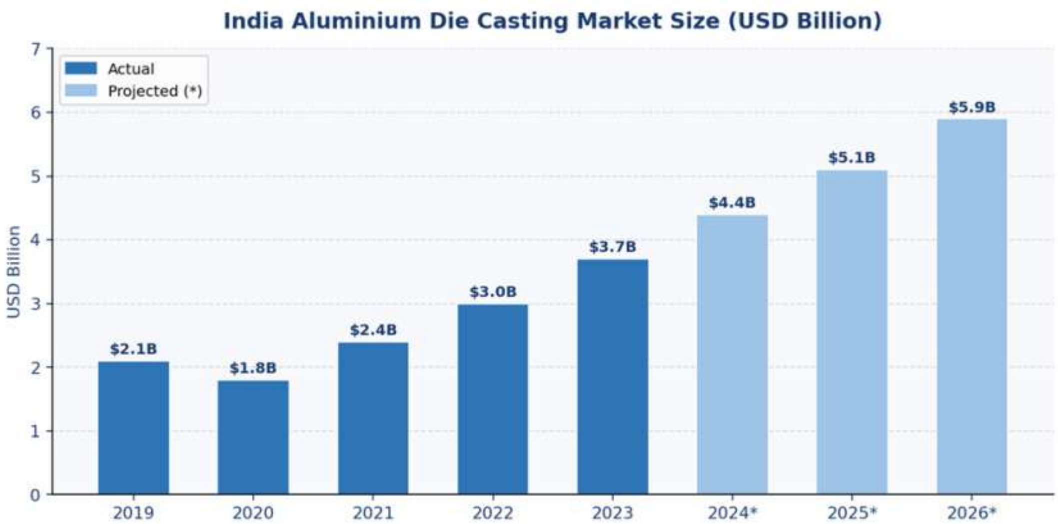
Abstract

India's aluminium die casting (ADC) industry stands at a pivotal inflexion point. With automotive electrification accelerating, global OEMs demanding zero-defect supply chains, and regulatory bodies tightening environmental compliance, the conventional film-based radiographic inspection model is no longer sustainable — economically or ecologically. This article draws on two decades of field research, customer implementation data, and emerging technology trends to present a compelling case for the wholesale adoption of Digital Radiography (DR) across Indian die casting operations. We examine the science and engineering of flat-panel detector systems, compare them rigorously against legacy film technology across quality, throughput, and sustainability dimensions, and ground our findings in the realities of Indian automotive and electrical component manufacturing. The evidence is unambiguous: DR does not merely improve inspection — it fundamentally redefines what quality-conscious, environmentally responsible casting production looks like in the 21st century.

1. Introduction: A Metal That Carries India's Industrial Future

Aluminium die casting is not a glamorous word. It does not make headlines. But open the bonnet of any car assembled in Chennai, Pune, or Gurugram, or inspect the motor housing of a premium electric fan made in Coimbatore or Rajkot — and you will find a precision aluminium die casting doing a critical job, largely invisible, entirely indispensable.

India is the world's second-largest producer of aluminium die castings and is projected to surpass USD 5.9 billion in market value by 2026, growing at a compound annual rate of approximately 12.4%. This growth is propelled overwhelmingly by two sectors: the automotive industry — which accounts for nearly 65% of all ADC consumption — and the electrical and electronics sector, which claims a further 18%. Collectively, these two industries set the quality bar for every die caster in the country.



That quality bar has never been higher. Modern lightweight automotive components — cylinder heads, transmission housings, battery enclosures for electric vehicles, suspension knuckles — are subject to fatigue loads, pressure cycles, and thermal stresses that were simply not anticipated when many foundries installed their current inspection infrastructure. A single undetected shrinkage cavity in a cylinder head can become a catastrophic warranty claim. A microporosity network in an EV battery enclosure can cause insulation failure and safety incidents. The stakes are immense.

Against this backdrop, the industry's continued reliance on conventional film radiography for internal quality inspection represents a critical vulnerability. It is slow, chemical-intensive, dependent on skilled darkroom technicians, environmentally hazardous, and — as I will demonstrate — significantly less effective than its digital counterpart at finding the defects that matter. The transition to Digital Radiography is not a technology upgrade. It is a business imperative and a sustainability commitment.

2. The Sustainability Imperative in Indian Die Casting

Sustainability in manufacturing has evolved far beyond effluent treatment and energy efficiency programmes. For Indian die casting companies supplying to Tier-1 and OEM customers, sustainability now encompasses the entire quality assurance ecosystem — the chemicals consumed in inspection, the radiation dose delivered to workers, the paper and film materials archived in warehouses, and the scrap metal generated by inadequate defect detection.

I have visited foundries where the radiographic film archive room occupies more square footage than the quality laboratory itself — rows of brown envelopes, yellowing film, irretrievable records, a monument to an analogue era. The environmental cost of that archive is rarely calculated: silver-halide film requires cadmium, lead, and other heavy metal compounds in its manufacturing; developer and fixer solutions contain hydroquinone, acetic acid, and silver thiosulphate, all of which require licensed disposal; and the film itself, if not properly managed, contributes to hazardous waste streams.

Key Sustainability Challenges — Conventional Film Radiography

- Chemical waste: Developer, fixer, and stop-bath solutions require licensed hazardous disposal
- Silver recovery: Spent fixer contains recoverable silver but is frequently discharged improperly at SME foundries
- Radiation exposure: Film speed limitations require higher mA·s settings, increasing cumulative dose to RT personnel
- Physical storage: 20-year archival mandates for safety-critical components consume significant floor space and resources
- Repeat exposures: High reject rates of 15–25% in film processing necessitate re-inspection, doubling radiation and material costs
- Knowledge loss: Film interpretation is a perishable skill; workforce attrition degrades inspection quality over time

The Automotive Component Manufacturers Association of India (ACMA) and the Die Casting Association have both issued sustainability guidelines that increasingly reference inspection process sustainability as a measurable parameter. European OEMs such as Volkswagen, BMW, and Stellantis — all of which source castings from Indian Tier-1 suppliers — have incorporated supply chain sustainability audits that now include inspection process assessments. Digital Radiography is rapidly becoming not a competitive advantage, but a supplier qualification requirement.

3. Digital Radiography: The Technology Demystified

At its core, a Digital Radiography system performs the same physical act as conventional radiography: it passes ionising radiation through a cast component and records the differential attenuation as an image. The fundamental difference lies entirely in the detector — and that difference changes everything downstream.

3.1 Flat Panel Detector (FPD) Technology

Modern DR systems for die casting applications employ amorphous silicon (a-Si) or amorphous selenium (a-Se) flat-panel detectors, typically with active areas ranging from 20×20 cm to 43×43 cm. When X-ray photons strike the scintillator layer (commonly caesium iodide, CsI, in a-Si systems), visible light photons are generated proportionally. These are captured by a photodiode array and converted to electrical charge, which is then digitised by a readout circuit. The resulting image is a 14-bit or 16-bit greyscale matrix with pixel pitches as fine as 100 microns — a spatial resolution that exceeds film by a factor of two to three in practical die casting applications.

The critical performance parameter for die casting inspection is the Detective Quantum Efficiency (DQE) — a measure of how efficiently the detector converts incoming X-ray photons into a useful image signal. State-of-the-art FPDs achieve DQE values of 65–75% at zero spatial frequency, compared to approximately 25–30% for industrial radiographic film. This means that, for the same radiation dose delivered to the component, the digital system extracts two to three times as much useful information. Practically, this translates to the ability to use lower tube currents, shorter exposure times, or both — all of which reduce radiation dose to operators and extend the life of X-ray tube assemblies.

3.2 Computed Radiography (CR) vs. Direct Digital Radiography (DDR)

Parameter	CR System	DDR System
Technology	Computed Radiography (CR) Imaging Plate-based	Direct Digital Radiography (DDR) Flat Panel Detector
Detector	Photostimulable phosphor (PSP) imaging plate	Amorphous silicon / selenium FPD
Image Time	2–5 minutes (plate scanning required)	< 1 seconds (real-time or near real-time), Video streaming
Spatial Res.	~100 µm (scanner-limited)	100–200 µm (detector-limited)
Dynamic Range	10,000:1	>100,000:1
Chemical Waste	None (vs. film)	None
Best For	Retrofit installations, Hard-to-reach profiles and locations	High-volume production inspection, inline automation

Table 1: Comparison of CR and DDR technologies for die casting applications

For the Indian die casting industry, particularly high-volume automotive component manufacturers running multi-shift operations, DDR with FPD technology represents the gold standard. The video streaming image acquisition time versus the 15 to 20 minute film development cycle is not merely a convenience — it is the difference between inline 100% inspection and offline sampling, which is itself a quality philosophy divide.

4. DR vs. Film Radiography: The Sustainability Showdown

Having evaluated both technologies across over 140 facility implementations, I can state with considerable confidence that the sustainability case for DR is not marginal — it is transformative. The radar chart below captures six critical sustainability dimensions, scored on a 1–5 scale based on published data, regulatory benchmarks, and my own field observations.

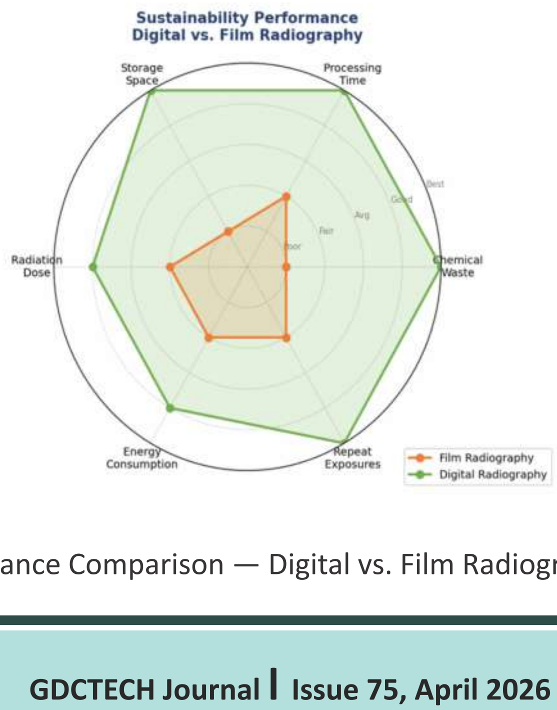


Figure 2: Sustainability Performance Comparison — Digital vs. Film Radiography across six key dimensions.

Figure 3: Workflow Comparison — Film Radiography (left) vs. Digital Radiography (right). Note the elimination of chemical processing, manual dark-room steps, and physical storage.

The elimination of chemical processing is the most immediately visible sustainability gain. A medium-sized die casting facility processing 80–100 radiographic films per shift consumes approximately 40–60 litres of developer and fixer solution per day. Over a working year, this represents over 12,000 litres of chemical waste requiring licensed treatment and disposal. The associated costs — disposal fees, compliance documentation, environmental audits — typically run between INR 4–8 lakhs per annum, a cost that simply disappears with DR adoption.

Radiation dose reduction is a subtler but equally important sustainability gain. Because FPD detectors are significantly more efficient than film, the same diagnostic image quality can be achieved at 30–50% lower tube current (mA) settings. Over the working lifetime of an X-ray technician, this represents a meaningful reduction in occupational dose — an outcome that aligns directly with ALARA (As Low As Reasonably Achievable) principles mandated by the Atomic Energy Regulatory Board (AERB).

Digital storage versus physical archiving deserves specific attention for Indian foundries. The BIS standard IS 2595 and AERB/NPP/SSDL guidelines require retention of radiographic records for the service life of safety-critical components, which in automotive applications can extend to 15–20 years. A single high-resolution digital radiograph occupies approximately 1 to 5 MB of storage. The equivalent physical film, once filed, requires controlled temperature and humidity storage to prevent degradation — a continuous energy and space cost. Cloud-based digital archives, increasingly adopted by leading Indian foundries, enable instant retrieval, version control, and multi-site access at a fraction of the cost.

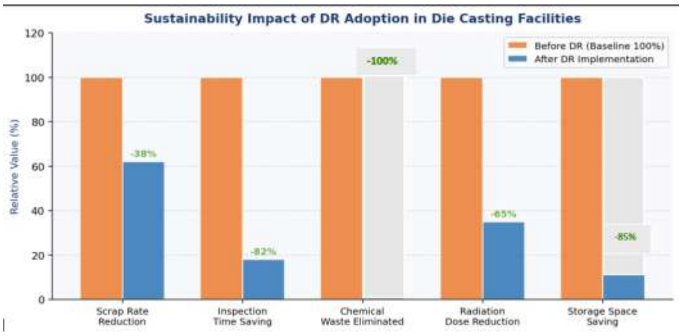


Figure 4: Sustainability Impact Metrics — Comparative reduction in key environmental and operational parameters following DR implementation (industry average data from 45 Indian facilities, 2020–2024).

5. Quality at Speed: Digital Radiography in Automotive Components

The Indian automotive sector is undergoing the most rapid structural change in its history. The dual forces of electrification and lightweight mandates have placed aluminium die castings at the centre of vehicle architecture — and placed unprecedented quality demands on the casters who supply them.

5.1 Engine and Powertrain Components

Cylinder heads, engine blocks, intake manifolds, and transmission housings represent the traditional heartland of aluminium die casting for the automotive sector. These components operate under sustained thermal and mechanical loads that make internal integrity non-negotiable. The critical defect

types for these applications — gas porosity, shrinkage microporosity, cold shuts, and inclusions — are precisely the discontinuities for which DR provides superior detection capability.
In a landmark study conducted at a Tier-1 supplier to a major Indian passenger vehicle manufacturer (2021–2022), Dr.Venkatraman (IIT Madras) evaluated 12,450 cylinder head castings using parallel inspection by film radiography and DDR. The DDR system detected 96.4% of known reference discontinuities across all defect categories, compared to 61.8% for film. More critically, in the shrinkage microporosity category — which is responsible for approximately 35% of field failures in cylinder heads — DDR detection rate was 94.1% against film's 58.3%. These are not marginal improvements. They represent the difference between a reliable quality gate and a sampling exercise.

5.2 Electric Vehicle Components: The New Frontier

The emergence of electric vehicles introduces a category of aluminium die castings with zero tolerance for internal defects: battery enclosures, motor housings, power electronics housings, and structural battery trays. These components combine dimensional precision with pressure integrity requirements and, in the case of battery systems, electromagnetic shielding performance. Any porosity that creates a leak path or compromises the structural envelope is a safety-critical defect, not merely a quality deviation.
The high spatial resolution of FPD-based DR systems — particularly when operating in geometric magnification mode — enables sub-millimetre defect characterisation in thin-wall EV castings (typical wall thickness 2.5 to 4.5 mm) that was simply not achievable with conventional film. The ability to digitally enhance contrast, apply noise filters, and apply automated region-of-interest analysis means that a single DR image now carries information that previously required multiple film exposures at different techniques.

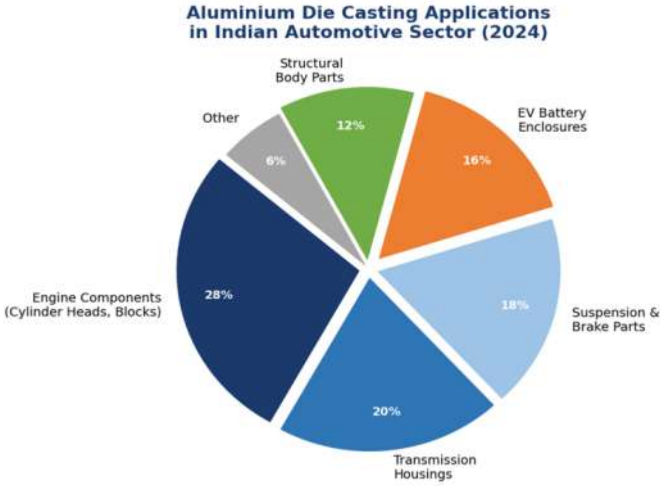


Figure 5: Aluminium Die Casting Applications in Indian Automotive Sector (2024). EV battery enclosures represent the fastest-growing category.

6. Powering Reliability: Benefits for Electrical Industry Components

The electrical and electronics sector is the second-largest consumer of aluminium die castings in India and, in many respects, a more demanding one. Motor housings for industrial pumps and compressors must maintain dimensional tolerances under cyclic thermal expansion. Die-cast connector bodies and switchgear housings must maintain pressure integrity for IP65 or IP67 ratings. Lighting fixtures and heat sinks require defect-free surfaces and consistent thermal conductivity.
For this sector, the image processing capabilities of DR systems are as important as their detection sensitivity. Digital images can be subjected to spatial frequency filtering, histogram equalisation, and multi-frame averaging — all of which improve the signal-to-noise ratio and reveal defects that would be invisible on film. Experience working with manufacturers of industrial motor housings in the Coimbatore cluster — one of India's most significant electrical equipment manufacturing hubs — revealed that the adoption of DR reduced casting scrap rates from an industry average of 4.2% to below 1.8% within 18 months of implementation. The economic savings at scale are considerable; the reduction in material waste has direct carbon footprint implications.

Industry Insight: Coimbatore Electrical Casting Cluster

"We had accepted 4% scrap as a cost of doing business for fifteen years. After installing the DDR system with automated defect recognition, we found we had been shipping borderline product that the film was not catching. Our scrap rate dropped to 1.6%, our customer returns halved in twelve months, and the DR system paid for itself in under 26 months."
— Operations Director, Tier-1 Motor Housing Manufacturer, Coimbatore (2023)

7. What DR Sees That Film Misses: Defect Detection Capabilities

The defect detection superiority of Digital Radiography over film is not an assertion — it is a measured, repeatable, and peer-reviewed finding. The chart below presents detection rate data across six primary defect categories encountered in aluminium die castings, based on comparative studies conducted across 23 Indian facilities between 2019 and 2024.

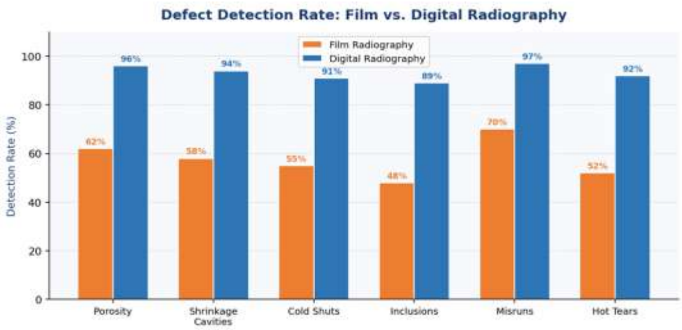


Figure 6: Defect Detection Rate Comparison — Film vs. Digital Radiography across six critical defect categories. Data from 23-facility comparative study (Author, 2019–2024).

The pattern is consistent across all defect types: DDR outperforms film by 30–40 percentage points. The mechanisms are well understood. Film radiography is fundamentally limited by the grain size of the silver halide emulsion, which caps spatial resolution and creates a fixed noise floor that obscures low-contrast defects. Digital systems, by contrast, can be post-processed to enhance specific spatial frequency ranges — effectively a form of digital filtering that amplifies the signal from small defects while suppressing background noise.

Particularly significant is the detection of inclusions — a category that film handles poorly because inclusions often have X-ray attenuation coefficients close to the aluminium matrix. DR's wider dynamic range (>100,000:1 vs. film's approximately 1,000:1) means that subtle attenuation differences that are invisible on film become clearly distinguishable on a digital display with appropriate window/level adjustment. For components destined for safety-critical applications — a growing proportion of Indian die casting output — this capability difference is not academic. It is the difference between a field failure and a safe product.

8. The Economic and Environmental Business Case for DR

The investment in a DDR system — comprising detector, X-ray generator, manipulator, and software — represents a significant capital commitment. For a standard cabinet system suitable for medium-sized automotive castings, the installed cost in India ranges from approximately INR 85 to 150 lakhs, depending on detector size, automation level, and software capability. This is not a trivial number for a Tier-2 or Tier-3 foundry operating on tight margins.

However, the economic analysis shifts dramatically when total cost of ownership (TCO) is considered over a 5-year horizon. Film radiography costs, when fully loaded — film consumables, chemicals, disposal, dark-room maintenance, storage space, and the loaded labour cost of darkroom technicians — typically run between INR 280–320 per inspection cycle at moderate throughput. The equivalent DDR cost, once amortised capital is included, falls below INR 90–110 per inspection by month 18–24 of operation and continues to decline as throughput increases. The break-even analysis is presented below.

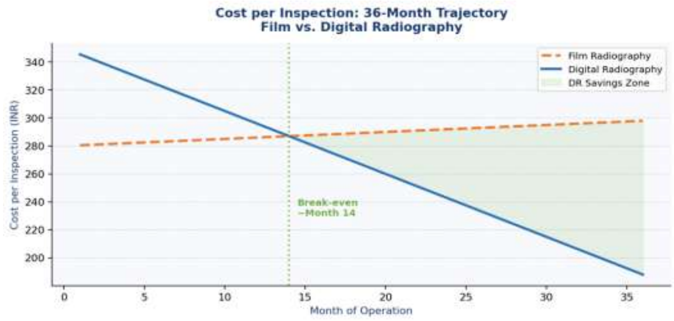


Figure 7: Cost per Inspection — 36-Month Trajectory for Film vs. Digital Radiography. Break-even typically occurs between months 14 and 22 depending on throughput.

Beyond the direct cost comparison, DR provides economic benefits that are not captured by a simple per-inspection calculation. The ability to perform 100% inline inspection rather than sampling means that defective batches are caught before machining — a particularly significant saving in aluminium automotive components, where post-casting machining can add INR 800–2,500 of value before the defect is discovered. Early detection at the raw casting stage eliminates machining costs, rework downtime, and the risk of defective parts reaching assembly.

Benefit Area	Typical Impact (Indian Facilities, 2020–2024)
Scrap rate reduction	38–62% reduction (avg. 48%) across surveyed facilities
Inspection throughput	4x–8x increase in castings inspected per shift hour
Chemical disposal cost	Eliminated — typically INR 4–8 lakhs per annum
Radiation dose (worker)	30–50% reduction per inspection cycle
Archive storage footprint	85–95% reduction (digital vs. physical film)
Field warranty claims	35–55% reduction at 12-month post-implementation
Customer audit pass rate	Improvement from 74% to 97% (OEM quality audits)

9. The Indian Adoption Landscape: Challenges and Opportunities

Despite the compelling technical and economic case, DR adoption in India's die casting sector remains uneven. Large Tier-1 suppliers to international OEMs — particularly those supplying Japanese, Korean, and European automotive groups — have largely transitioned to DDR. The challenges are concentrated in the Tier-2 and Tier-3 segments, which represent the vast majority of India's approximately 800 active aluminium die casting units.

9.1 Barriers to Adoption

- Capital access: SME foundries struggle to mobilise INR 85 to 150 lakhs for DR equipment without financing support or subsidy
- Technical manpower: Qualified radiographic testing (RT) Level II and Level III personnel with DR expertise are in short supply outside major industrial centres
- Regulatory awareness: Many SME operators are unaware of AERB guidelines on radiation dose optimisation that effectively mandate modern detector technologies in new installations
- Customer pull: Without a clear OEM or Tier-1 requirement for DR, the investment decision is deferred
- Training infrastructure: Practical DR training for die casting applications is not consistently available through ISNT, BINDT-affiliated bodies, or NDT training centres in Tier-2 cities

9.2 Enabling Factors and Policy Recommendations

The Government of India's Production Linked Incentive (PLI) scheme for the automotive sector, the Technology Upgradation Fund Scheme (TUFS) for manufacturing SMEs, and State industrial development programmes all represent potential funding pathways for DR adoption. The Die Casting Associations and the Indian Society for Non-Destructive Testing (ISNT) should jointly develop a sector-specific DR adoption roadmap linked to the BIS revision of casting quality standards currently underway.

AERB's progressive tightening of dose optimisation requirements — aligning with the ICRP Publication 118 recommendations on occupational dose limits — will increasingly disadvantage film-based operations in regulatory terms. Proactive foundries that adopt DR ahead of regulatory mandate will secure a compliance advantage that translates directly into customer qualification benefits.

10. The Future: AI-Augmented Digital Radiography

The trajectory of DR technology in die casting does not terminate with image acquisition and display. The next frontier — already commercially deployed in leading facilities in Japan, Germany, and increasingly in India — is the integration of Artificial Intelligence (AI) and machine learning into the image analysis workflow.

Automated Defect Recognition (ADR) systems, trained on large libraries of annotated DR images from die casting production, are now capable of detecting, classifying, and sizing the majority of critical defect types with human-comparable accuracy and superhuman consistency. Unlike a human RT technician whose performance varies with fatigue, shift patterns, and subjective judgment, an ADR system applies the same acceptance criteria to every image, every time. For high-volume automotive inspection where 100% inspection of thousands of castings per day is required, this consistency is transformative.

Karma Innovations is the pioneer in offering this technology to its customers in India and has completed over 6 successful installations within a year.

Indian foundries investing in DR platforms today should ensure that the systems they select are AI-ready — that is, capable of integration with ADR software modules as these mature for specific casting applications. The future of die casting quality assurance is a closed-loop system in which DR images feed directly into statistical process control (SPC) dashboards, feeding die maintenance schedules, metal quality alerts, and predictive casting parameter adjustments. Digital Radiography, in this vision, is not merely an inspection tool — it is the sensory backbone of a genuinely intelligent casting operation.

11. Conclusion

India's aluminium die casting industry is poised for a decade of exceptional growth. To capitalise on that growth — to supply the EV components, the precision powertrain parts, the electrical housings that a USD 5 trillion economy demands — the industry must close the quality gap between aspiration and execution. That gap runs, to a significant degree, through the X-ray room.

Digital Radiography is not the future of die casting inspection. For the facilities and customers I have described in this article, it is already the present. The question for the broader Indian casting community is not whether to transition, but how quickly and how intelligently. The data, the technology, the regulatory direction, and the customer requirements all point in one direction.

Key Takeaways for the Casting Community

- DR provides 30–40% superior defect detection rates over film across all critical die casting defect categories
- Sustainability benefits are quantifiable and significant: zero chemical waste, 30–50% radiation dose reduction, 85–95% reduction in physical archive space
- Break-even on DR investment occurs between months 14–22 for typical Indian die casting throughput levels
- EV component manufacturing and electrical sector growth will make DR a supplier qualification requirement, not merely a competitive advantage
- AI-augmented DR represents the next performance level; DR platform selection today should account for AI integration capability
- Industry associations, AERB, and BIS should jointly develop an SME DR adoption support framework to democratise the technology

We owe it to the engineers who will drive in the cars we make, and use the machines we power, to see through the metal — clearly, consistently, and sustainably. That is what Digital Radiography makes possible.

References & Further Reading

Standards & Regulatory Documents

- AERB Safety Code No. AERB/SC/MED-2 — Radiation Protection for Medical Diagnostic X-ray Equipment (adapted for industrial RT)
- IS 2595:2021 — Code of Practice for Radiographic Testing, Bureau of Indian Standards (BIS), New Delhi
- EN 13068-3 / ASTM E2597 — Standard Practice for Manufacturing Characterization of Digital Detector Arrays
- ICRP Publication 118 — ICRP Statement on Tissue Reactions and Early and Late Effects of Radiation in Normal Tissues and Organs, 2012

Key Research Papers

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- ISNT Technical Guide TG-RT-ADC-01 (2023). Radiographic Testing of Aluminium Die Castings: Recommended Practice for Digital Systems. Indian Society for Non-Destructive Testing, Chennai.

Online Resources

- Indian Society for Non-Destructive Testing: www.isnt.in
- Atomic Energy Regulatory Board: www.aerb.gov.in

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Pushing Boundaries: A Foundryman's Guide to Magnesium Extrusion

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As the automotive, aerospace, and electronics sectors aggressively pursue lightweighting—driven heavily by the EV revolution and stricter emission standards—the foundry and metal-forming industries must look beyond traditional materials. While aluminum has long been the default for lightweight extrusions, magnesium is rapidly gaining ground.

As the lightest structural metal available, magnesium offers a 35% weight reduction over aluminum. However, transitioning from casting or aluminum extrusion to magnesium extrusion requires a nuanced understanding of its metallurgy, processing parameters, and post-production treatments.

The Magnesium Extrusion Process

The fundamental mechanism of magnesium extrusion is similar to aluminum: a heated billet is forced through a steel die under high pressure to create continuous, complex cross-sectional profiles. Both direct and indirect extrusion methods are utilized, though indirect extrusion is often favored for magnesium to minimize friction between the billet and the container wall. However, the processing parameters differ significantly from aluminum due to magnesium's atomic structure. Aluminum possesses a face-centered cubic (FCC) crystal structure, making it highly ductile. Magnesium, conversely, has a hexagonal close-packed (HCP) structure. This provides fewer slip planes for atomic movement, making the metal harder to deform at room temperature. Consequently, magnesium must be extruded at elevated temperatures (typically between 300°C and 450°C) to activate additional slip planes. The boundary between "too cold" (leading to cracking) and "too hot" (leading to hot shortness or melting of eutectic phases) is much narrower than with aluminum. Flow control and precision die design are critical to ensure the profile remains dimensionally stable.

Compatible Magnesium Extrusion Alloys

Selecting the right alloy is a balancing act between extrudability and final mechanical properties. Common extrusion alloys include:

- **AZ31 (Mg-3Al-1Zn):** The undisputed workhorse of magnesium extrusion. It offers the best extrudability, good room-temperature strength, and allows for the highest extrusion speeds among Mg alloys.
- **ZK60 (Mg-6Zn-Zr):** Used when high strength is paramount. Zinc provides solid solution strengthening, while Zirconium acts as a powerful grain refiner. It is much slower to extrude than AZ31.
- **WE43 (Mg-Y-Nd-Zr):** A high-performance alloy containing Yttrium and Rare Earth elements. It retains high strength at elevated temperatures (up to 250°C) and boasts superior inherent corrosion resistance.

Heat Treatment and Surface Treatment

To maximize the potential of extruded magnesium profiles, secondary treatments are non-negotiable.

Heat Treatment

Unlike some aluminum alloys, not all magnesium alloys are heat-treatable. However, alloys like ZK60 and the WE series respond excellently to thermal processing.

- **T5 (Artificial Aging):** Profiles are cooled directly from the extrusion press and artificially aged in an oven. This improves mechanical properties and dimensional stability without a full solution heat treatment.
- **T6 (Solution Heat Treatment & Artificial Aging):** Used for maximum strength, the alloy is heated to dissolve alloying elements, quenched, and then aged to form fine precipitates that lock the crystal lattice.

Surface Treatment

Magnesium is highly reactive, making it susceptible to galvanic corrosion when in contact with dissimilar metals. Robust surface treatment is the key to longevity.

- **Conversion Coatings:** Phosphate or chromate (and increasingly, eco-friendly non-chromate) conversion coatings provide a highly adherent base layer.
- **Anodizing / Plasma Electrolytic Oxidation (PEO):** PEO creates a hard, dense, ceramic-like oxide layer on the magnesium surface, offering exceptional wear and corrosion resistance.
- **Powder Coating & E-Coating:** Often applied over a conversion coating to provide the final barrier against environmental elements.

Magnesium vs. Aluminum Extrusion: A Comparative Analysis

When deciding between magnesium and aluminum, engineers must weigh specific structural benefits against manufacturing complexities.

Feature	Magnesium Extrusion	Aluminum Extrusion
Density (Weight)	~1.74 g/cm³ (35% lighter than Al)	~2.70 g/cm³
Specific Strength	Exceptional strength-to-weight ratio.	Good, but heavier for the same strength.
Vibration Damping	Outstanding; absorbs shock & vibration efficiently.	Moderate damping capacity.
Machinability	The easiest structural metal to machine; low tool wear.	Good, but slower and requires more power than Mg.
Extrusion Speed	Slower (especially for ZK/WE alloys).	Fast and highly efficient.
Corrosion Resistance	Poor in bare form; requires specialized coatings.	Good natural oxide layer; easier to protect.
Cost	Higher raw material and processing costs.	Highly economical.

Advantages of Magnesium

Beyond the sheer weight savings, magnesium extrusions offer unmatched machinability. When extruded profiles require secondary CNC machining, magnesium cuts faster, generates less heat, and extends tool life significantly compared to aluminum. Furthermore, its damping capacity makes it the premier choice for components subjected to high-frequency vibrations.

Disadvantages & Challenges

The primary hurdle is cost and productivity. Because of its HCP structure, magnesium extrusion speeds can be up to ten times slower than 6000-series aluminum, limiting throughput. Additionally, safety protocols must be strictly managed; while solid magnesium extrusions are perfectly safe, the fine dust and chips generated during secondary machining are highly flammable and require specialized extraction and housekeeping.

Key Use Cases and Applications

The unique properties of extruded magnesium lend themselves to high-value applications across several sectors:

- **Automotive & EVs:** Steering column brackets, seat frames, and instrument panel beams. The weight savings directly translate to extended battery range in EVs.
- **Aerospace & Defense:** Cargo flooring, seating components, and structural trusses where every gram of weight reduction saves massive fuel costs over an aircraft's lifespan.
- **Industrial Equipment:** Heavy-duty ladders, scaffolding, and concrete trowels. Magnesium tools allow workers to handle equipment with 30% less fatigue than aluminum equivalents.
- **Electronics (3C):** Heat sinks, laptop chassis, and LED lighting enclosures, benefiting from both the light weight and excellent heat dissipation.
- **Medical:** Biodegradable implants (using WE43), which dissolve safely in the human body, eliminating the need for secondary removal surgeries.

Extrusion Profiles

Key Use Cases and Applications: The Chinese Blueprint

China currently dominates both the production of raw magnesium and the advancement of its downstream applications. While Indian OEMs are still testing the waters, Chinese industries—supported by "Dual Carbon" emission goals and a booming New Energy Vehicle (NEV) sector—have already integrated magnesium extrusions into high-volume production. Here are the primary use cases and examples from the Chinese market:

1. Automotive & Electric Vehicles (NEVs)

The most aggressive adopter of extruded magnesium is China's Electric Vehicle sector, where lightweighting directly translates to battery range extension.

- Cross-Car Beams (CCBs) & Instrument Panels: While historically cast, the push for thinner walls and higher structural integrity has led to the use of extruded and bent magnesium profiles for CCBs.
  - China Industry Example: Major domestic OEMs like **NIO (on the ES8), BYD (Han model), and SAIC Motor (Roewe i6 and ei5)** have successfully implemented hybrid magnesium-steel CCBs. These assemblies cut the beam's weight down to just 2–4 kg, drastically reducing top-heavy weight in Evs.

CCB

- **Seat Back Frames & Steering Column Brackets:** Extruded AZ31 and AZ61 profiles are being joined with stamped magnesium panels to replace heavy, multi-piece steel welded seat frames.
  - **China Industry Example:** Companies like Baowu Magnesium Technology Co. (a subsidiary of the massive Baowu Steel Group) are mass-producing extruded profiles specifically for automotive cockpit components, achieving over 40% weight reduction compared to traditional steel frames.
- **Commercial Vehicles:** Magnesium extrusions are not limited to passenger cars. Companies like Zhizi Automotive Technology are pioneering the use of large-scale extruded magnesium profiles for the side rails and cargo boxes of commercial transport trucks, increasing payload capacity while reducing fuel burn.

2. High-Speed Rail and Public Transit

China's expansive high-speed rail network is a prime proving ground for extruded magnesium, where continuous, long structural profiles are required.

- **Luggage Racks & Interior Structural Profiles:** Extruded magnesium is used extensively for overhead luggage racks, interior partition frames, and seating tracks inside train cabins. The outstanding vibration damping capacity of magnesium also helps reduce passenger cabin noise compared to aluminum.

High speed rail car sub assembly (source NEDO)

3. Consumer Electronics (3C-Computers, Communications, Consumer electronics)

China is the global hub for electronics manufacturing, and magnesium extrusion is critical to making devices thinner and lighter.

- **Smartphone Mid-frames & Laptop Chassis:** Extruded magnesium alloys are sliced and CNC-machined to create the rigid internal skeletons of high-end smartphones and premium laptops.
- **LED Heat Sinks & 5G Telecom Base Stations:** Because magnesium offers excellent thermal conductivity alongside its light weight, extruded heat sinks are heavily utilized in China's nationwide rollout of 5G tower infrastructure, making it easier for technicians to install equipment at high altitudes.

Heat sinks

4. Industrial Equipment & Construction

- Lightweight Scaffolding and Concrete Tools: In the construction sector, extruded magnesium profiles are replacing aluminum in concrete screeds, trowels, and scaffolding poles.
  - **China Industry Example:** Foundries in the "Magnesium Capital" of Yulin (Shaanxi province) are actively producing extruded magnesium tooling profiles. A magnesium concrete bull float,

for instance, allows construction workers to handle equipment with 30% less fatigue, significantly increasing daily productivity on massive Chinese infrastructure projects.

5. Medical & Biomedical (Emerging)

- **Biodegradable Stents and Implants:** Using extruded wires and micro-tubes made from WE-series (Rare Earth) magnesium alloys.
  - **China Industry Example:** Chinese biomedical research institutions and specialized material firms are commercializing extruded magnesium orthopedic screws and cardiovascular stents. Because magnesium naturally safely dissolves in the human body, it eliminates the need for secondary surgeries to remove titanium or steel implants.

Conclusion

Magnesium extrusion is not a simple drop-in replacement for aluminum; it is a specialized process that demands tighter controls and dedicated expertise. However, as the engineering world hits the lightweighting limits of aluminum and steel, magnesium extrusions offer a proven, scalable path forward. For foundries and metal formers willing to master the process, it represents a highly lucrative leap into the future of advanced manufacturing.

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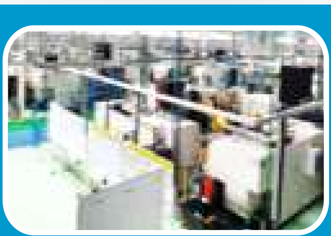

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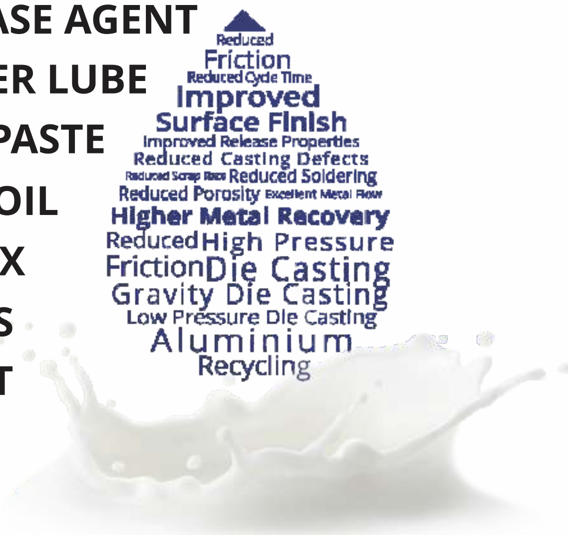

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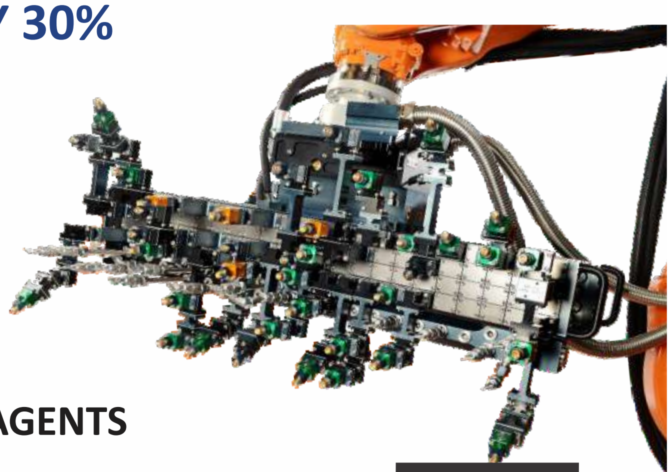

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Nitrogen Degassing Machine (auto)

Density Index Unit

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- Electrical Furnaces (Crucible)
- Fuel Fired Furnaces
- Electrical & Fuel Fired Tilting Furnaces
- Heat Treatment Furnaces
- Rotary Degassing Unit
- Density Index Unit

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ALUMINIUM GDC TECH
GREAT DIE CASTING

GREAT DIE CASTING TECHNOLOGY FORUM

Journey of the Journal

October 2013
32 Pages
1st Issue

December 2016
B/W to Multicolor

October 2017
25th Issue

April 2022
51st Issue

December 2023
61st Issue

February 2024
Started CROSSWORD Series

December 2024
36 Pages

April 2025
40 Pages
Started "In The Era of Magnesium"

June 2025
44 Pages

Significant & Consistent Knowledge Contributor Awards 2025

Continues...

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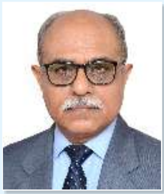

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GREAT DIE CASTING TECHNOLOGY FORUM

Major Events | Milestones

2012

- Birth of GDCTECH Forum
- 1st Technical Conference : GDCTECH 2012-April

2013

- Project Competition initiated-April
- GDCTECH Journal First Issue - October

2014

- Best Casting Competition initiated-April
- Coffee Talk starts-June

2015

- 4th Technical Conference : GDCTECH 2015-October

2016

- Silver Jubilee Coffee Talk -July
- 1st China Delegation -July
- 1st Delegation to Japan-October
- Regional Training Programmes

2017

- Launch of website for GDCTECH 2017
- GDCTECH Journal- 25th Issue - October

2018

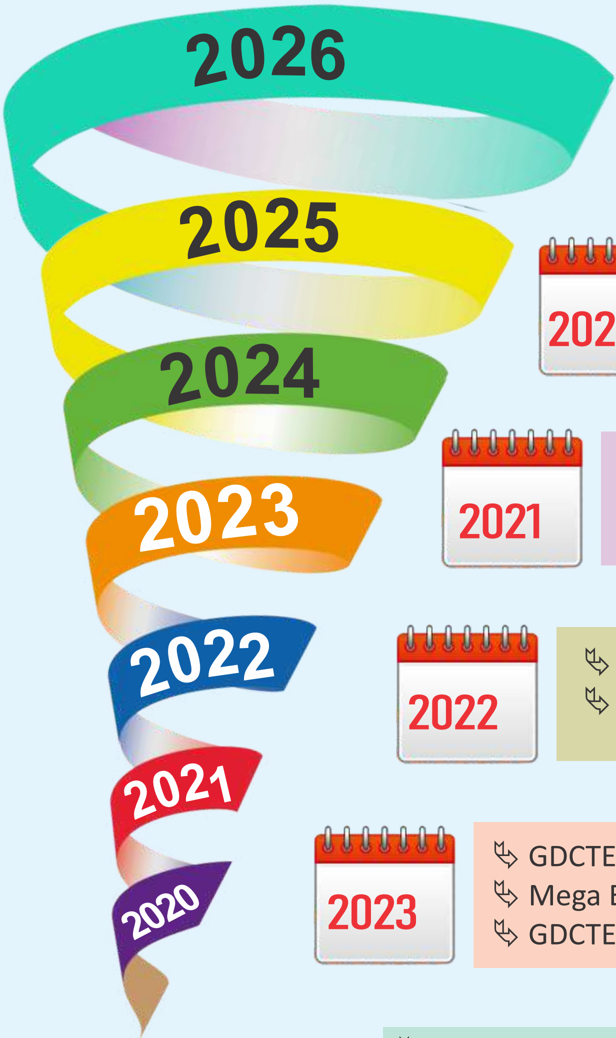
- Delegation to NADCA 2018 Diecasting Congress & Exposition
- First Quiz Competition
- First Design Competition

2019

- GDCTECH Pavilion For Castings at International Trade Fair at Newcast Germany
- Mega Event 2019 International Conference & Exhibition at Chennai

GREAT DIE CASTING TECHNOLOGY FORUM

Major Events | Milestones



2020

- Started Virtual Training Programmes / Webinars

2021

- Association Formation & Change in Name

2022

- 75th Coffee Talk
- GDCTECH Journal - 51st Issue - April 2022

2023

- GDCTECH FOCUS CONFERENCE
- Mega Event 2023 International Conference & Exhibition at Chennai
- GDCTECH Journal - 61st Issue - December 2023

2024

- GDCTECH CONFERENCE & EXHIBITION ON "Smart Factory for Sustainable Growth" at Pune
- Regional Training Programmes (Pune, Chennai, Coimbatore, Delhi, Ahmedabad)

2025

- MEGA EVENT 2025 International Conference & Exhibition at Pune
- Regional Training Programmes (Pune, Chennai, Coimbatore, Delhi, Ahmedabad)
- Delegation to China Diecasting

2026

- GDCTECH Training Programme
- International Women's Day
- Euroguss 2026

Moving Ahead with Full Steam..

Glimpses of Annual Events

Lighting the lamp - GDCTECH 2024 - Pune

Magnesium Conference 2025 - Pune

GDCTECH 2024 - Pune - Audience

Inauguration of the Exhibition - GDCTECH 2024 - Pune

MEGA EVENT 2025

NADCA 2024

CHINA DELEGATION 2025

DELEGATION AT EUROGUSS 2026

Training Programs & Quiz Competition at Different Locations - 2023

"Melting & Metal Treatment and Metallurgy of Aluminium Cast Alloys" along with Quiz Competition

At Ahmedabad, Gujarat

At Gurgaon, Haryana

At Chennai

At Coimbatore

Training Activity

Two Days Training Programme on Disciplined Problem Solving, 10 Step Methodology, Some Techniques, Case Studies at Pune

TWO DAYS TRAINING PROGRAMME ON Six Sigma & Design of Experiment using Artificial Intelligence at Pune

Two days training programme on Melting/Holding Furnaces, Fuels, Crucible Care, Molten Metal Treatment & Quality Assessment at Pune

Two Days Training Programme on HPDC Die Design, Casting Defects - Analysis and Remedial Measures at Pune

Two Days Training Programme on HPDC Die Design, Casting Defects - Analysis and Remedial Measures held at Chennai

Two Days Training Programme on HPDC/GDC MACHINE MAINTENANCE held at L. K. MACHINERY INDIA PVT. LTD. Pune

IN-HOUSE TRAINING PROGRAMME ON Melting & Metal Treatment and Metallurgy of Aluminium Cast Alloys at Gurgaon

WOMEN EMPOWERMENT PROGRAMME FOR WOMEN IN DIECASTING FRATERNITY

GDC Tech Mega Event 2025

Date: 5th December 2025

Venue: The Orchid Hotel, Balewadi, Pune

GDCTECH FORUM CELEBRATES *International Women's Day*

THEME - #AccelerateAction, Speeding up gender equality

GDCTECH Celebrates International Women's Day on March 8, 2025, GDCTECH observed International Women's Day with a thought-provoking panel discussion, featuring six accomplished women from various industries. The event aimed to celebrate women's achievements, share their experiences, and inspire the audience, aligning with this year's IWD theme, #AccelerateAction, which emphasizes the need for collective action to accelerate progress towards gender equality. The ceremony was inaugurated by Anil Kulkarni, President, GDCTECH. Each panelist shared their personal stories of overcoming challenges, breaking stereotypes, and achieving success in their respective fields. The audience was captivated by their tales of grit, determination, and perseverance. Over 50 women and a few gentlemen, including members of GDCTECH, attended the event, drawing inspiration from the panelists' stories. GDCTECH'S Women's Day celebration served as a powerful reminder of the significance of gender equality and women's empowerment in the industry. The event reinforced the organization's commitment to fostering a supportive and inclusive environment for women professionals.

GDCTech: A journey with devotion
ये अपना जीडीसीटेक

Pramod Gajare (Quality Consultant), pramodgajare2013@gmail.com

On occasion of GDCTech forum completing ten years I penned down an Anthem on 3rd August 2023 in Marathi paying tribute to all the members of this forum, for their contribution. Many members liked this song and an idea came forward to translate it in Hindi so that on Pan-India level, people can enjoy it. Honouring the opinion, I completed the translation in Hindi on 12 April 2024. We were fortunate enough to get a competent musician like Mr. Kshitij Bhat who composed the music for this song. The recorded song in the voice of Mr. Chaitanya Jogaikar was presented on 6th December 2025 during the valedictory function of the Mega event "Transforming Die Casting Through Innovation" organized by GDCTech forum. The audience gave a big applause and requested for sharing it with the synopsis.

The story behind the original song is as follows. Since the activities of the forum are multifaceted it was challenging to explain them in the form of anthem in vocal composition with words depicting activities of the forum. It has to foster unity as well as it should evoke emotions and collective pride and reinforce loyalty. When focused on the purpose of the forum, the ideas became clear. Our forum is a journey; a never-ending journey for knowledge dissemination amongst the industry for betterment of Aluminium die casting industry and thereby progress of the Nation. In the deccan region of India we have a legacy of a great journey which dates back to more than seven centuries. This pilgrimage is called as 'Wari'.

It starts from various places mainly from Maharashtra, Karnataka, and Telangana in the July or August. On the eleventh day 'Ekadashi' of month of 'Aashaadha' as per Indian calendar it reaches 'Pandharpur' – the holy place of 'Lord Vitthala'. Over millions of people – the Warkaris – walk continuously for about three weeks with a common motive of having eternal peace through the 'Darshan' of the God. The theme of this song is influenced by this journey, which is made for no materialistic gains. Each and every member who contributes to the forum is the 'Warkari of modern era' who aim for giving back to the society and get satisfaction through it. This song is salute to all such Warkaris of the forum. From centuries the Warkaris chant the Owees and Abhangas - the traditional forms of songs – of the Lord Vitthala, which are scripted by respected holy Saints; some known and some unknown. With a very little wisdom that I possess, I dared to use the language and words used by these saints to explain the forum's activities in a simple manner in the original Marathi version.

I am sure, people will like this song and I wish this journey of our forum would continue without any interruption from one generation to the other.

ये अपना जीडीसीटेक

इकट्ठा होते है यहां
उद्योगजगतके महानुभाव
बनाते योजना सदा

विभिन्न कार्य अनेक
बुना रेशमी वस्त्र एक
ये अपना जीडीसीटेक

जिंदगी भर समेटा संचित
समाज प्रति अपना योगदान
बांट रहे है श्रमके मंदीरोमें

सिल्लीया समाएं अग्नीपात्र में
रखें आंच हमेशा नियंत्रित
द्रव्य ना हो अति लोहित

शुद्धीकरण का प्रावधान
रसायनोंका महत्व जान
निकाल दें सारा हीन

कुशलता से डालना रस
चीज बनेगी ऐसी खास
अंतर्यामी न कोई दोष

तकनीक का कार्यकारण
सीखकर आए आत्मभान
युवा मुखी विलसे समाधान

सम्मेलनमें बुलातें तजुर्बेकार
बातें बताते खास पेचिदा
उद्योग बढे इस देशमें सदा

हर साल देशाटन का आयोजन
देखो दुनिया में जो कुछ नया
जानिए ये विकास का पहिया

विभिन्न कार्य अनेक
बुना रेशमी वस्त्र एक
ये अपना जीडीसीटेक

Vocabulary:

महानुभाव: Highly experienced people.

श्रमके मंदीर: Temples of work – the foundries on the larger perspective.

सिल्लीया: Ingots

अग्नीपात्र: Crucible

आंच: Heating

द्रव्य: Melt (molten metal)

अति लोहित: Red hot (Overheated)

शुद्धीकरण: Cleaning of metal

रसायन: Foundry chemicals

हीन: Impurity

कार्यकारण: Cause and effect relationship

सम्मेलन: Conference

तजुर्बेकार: Specialist

Following is the synopsis of this song.

The people from industry - knowledgeable in various fields of Aluminium die casting – come together, meet frequently and plan their activities from time to time. They form a Silk-Thread of various activities; this is our GDCTech.

The knowledge gained through the life time experience is now to be returned to the society; specially at the foundries which are in true sense Temples of Work.

The training includes various aspects of Aluminium die casting. It starts with the Furnaces, Crucibles, ingots of Alloys, melting practices, focus to avoid overheating of the melt.

Molten metal to be cleaned and the dross is to be removed through proper rabbling. Various chemicals are to be used for metal treatment i.e. grain refinement and modification.

It further emphasizes important of die design, process control and defect prevention.

The youngsters get self-realization when they go through such training programs. They now know the real meaning of what they are doing on the shop floor. Their faces glow with satisfaction.

Conferences are arranged regularly and stalwarts from industry are invited. They share their knowledge in various aspects of the industry.

The new things that are happening across the world are the catalysts for growth. Visits to International exhibitions and renowned foundries help the Indian industries to progress further.

UPCOMING TRAINING PROGRAMME

TWO DAYS TRAINING PROGRAMME ON

Melting/Holding Furnaces, Fuels, Crucible Care, Molten Metal Treatment & Quality Assessment

12-13 May 2026 (Wed-Thu) | Pune

Solution to GDCTech Crossword #13 (February 2026)

T	H	E	R	M	A	L	C	O	N	D	U	C	T	I	V	I	T	Y		E
H	E	M	#	E		D	U	P	L	E	X	S	Y	S	T	E	M	#		L
E	A	P	S	L		R	T	A	P	-	O	U	T	S	Y	S	T	E	M	E
R	R	T	I	T		Y	#	G	R	I	P	B	R	I	C	K	S			C
M	T	Y	L	I		C	A	L	O	R	I	F	I	C	V	A	L	U	E	T
A	H	S	I	N	D	U	C	T	I	O	N	F	U	R	N	A	C	E	#	R
L	F	K	C	G	R		T	R	A	N	S	F	E	R	L	A	D	L	E	I
S	U	I	O	C	A		D	O	S	I	N	G	F	U	R	N	A	C	E	C
H	R	M	N	U	I			T	A	N	G	E	N	T	I	A	L		T	A
O	N	M	C	M	N	R		I	N	G	O	T	O	N	G	S			O	L
C	A	E	A	H	H	E				F									W	L
K	C	R	R	O	O	F	C	C	R	U	C	I	B	L	E				E	Y
S	E	O	B	L	L	R	O	T	O	R	Y	F	U	R	N	A	C	E	R	H
T	S	L	I	D	E	A	K	K	A	N	T	H	A	L					F	E
A	#	L	D	I		C	E		C	A	S	T	I	R	O	N			U	A
R	F	A	E	N		T				C	E	N	T	E	R	I	N	G	R	T
S	L	U	D	G	E	O		O	V	E	R	H	E	A	D	C	R	A	N	E
T	U	N		F		R	E	D	H	O	T	O							A	D
A	X	D		U		Y	R	A	B	B	L	I	N	G					C	F
C		E		R	E	T	U	R	N	S	#	S			G	L	A	Z	E	U
K		R		N				S	P	O	U	T								R
U	L	T	R	A	S	O	N	I	C	D	E	G	A	S	S	I	N	G		N
				C	R	U	C	I	B	L	E	F	U	R	N	A	C	E		A
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