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Kañch

Quarterly Journal of **The All India Glass Manufacturers' Federation**

Bilingual

glasspex INDIA & glasspro INDIA 2025 (Page #s 37-46)

Release of book on Excellence in Container Glass Manufacturing (Page #s 49-50)

15th AIGMF International Conference on 'AI and Digitalisation – the future for sustainable glassmaking' (Page #s 27-31)

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- *Release of book on Excellence in Container Glass Manufacturing*
- *World Soda Ash Conference*
- *Launch of Calendar Glass Bottle 2026*
- *Chalcogenide Glasses: A vision beyond visible (Part-3)*

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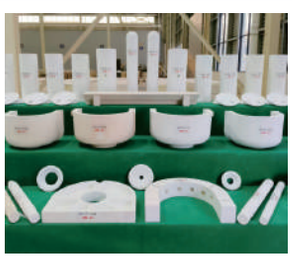

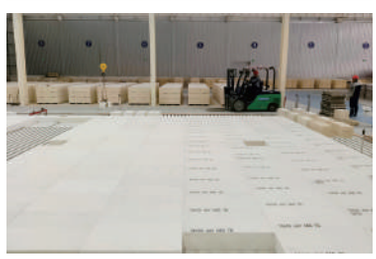

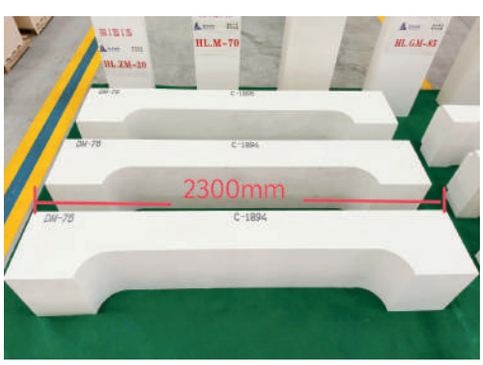

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PRODUCT RANGE

- Casting Blocks Series for Tank Bottom.
  - Fireclay Bottom Block
  - Sillimanite Bottom Block
  - Tin Bath Bottom Block
- High performance refractories applied to superstructure.
- Forehearth & feeder series
- Monolithic Material Series

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From the President's Desk

Parallel to the Container Glass promotion meeting of the AIGMF, the annual calendar for 2026 was unveiled on the theme 'Glass is Pure' or कांच जीवन है on Dec 24 at AIGMF Secretariat carrying best entries from the 2025 Youth contest.

As a supporting Association, AIGMF participated at the IntraPac India 2025, an exhibition on Packaging and Processing organised from Dec 10–13 at India Expo Centre, Greater Noida UTTAR PRADESH organised by the Indian Printing Packaging & Allied Machinery Manufacturers' Association (IPAMA), IntraPac India 2025 featured a comprehensive range of packaging solutions, machinery, and allied products, Packaging Technologies including Glass. The event aimed to bring together key players in the packaging industry, and provided insights into the latest trends and technologies.

The World Soda Ash Conference 2025 was held from October 7-9 at Palma Convention Centre, Palma de Mallorca, SPAIN focusing on market trends, sustainability, and networking opportunities. Participants got the opportunity to connect with industry leaders, producers, and buyers, providing a platform for valuable networking and collaboration. Like previous shows, AIGMF supported the event as a media partner. Mr. Aashish Tyagi, Member AIGMF and Director with Gold Plus Glass Industry Ltd., gave the presentation on Indian Market Scenarios: Flat, Solar Glass and Soda Ash Requirement. Some of the AIGMF members participated directly.

By all means, the first ever AI conference on glassmaking hosted by the AIGMF in association with Messe Düsseldorf and Glass Futures was a huge success. The 15th AIGMF International conference focused on the increased use of Artificial Intelligence (AI) and digital technology in glass manufacturing that was held parallel to the 3-day glasspex/glasspro INDIA exhibitions on Sept 11 at Bombay Exhibition Centre MUMBAI. The participants touched 135+ from all segments of glass, which was made possible with the support of sponsors namely- AGI, Cello, Dukhiram Maurya, HNG, La Opala, Mascot, NES and Yera.

Published by the AIGMF and authored by Er. Ashoka Rao Manikala, Former President Operations, PGP Glass and AGI Greenpac, a comprehensive book (Excellence in Container Glass Manufacturing) written with the sole intention of sharing knowledge and enhancing the understanding of those working in the glass industry was released on Sept 11 by the Office Bearers and Ex Com Members at the 15th International Conference of AIGMF on AI in glass manufacturing at MUMBAI.

Also, at the 15th AIGMF International conference on AI, the Calendar Glass Bottle 2026 was launched. The bottle has specially been designed by AGI glaspac from the recycled glass.

8th edition of glasspex INDIA & 5th edition of glasspro INDIA concluded on a high note at the Bombay Exhibition Center, MUMBAI from September 10-12. The exhibition was supported by the AIGMF and organized by Messe Düsseldorf India. Both events were powered by glasstec, Düsseldorf, GERMANY – the world's leading exhibition for the glass industry.

Detailed coverage of above events is covered in this edition of Kanch and is also available on www.aigmf.com along with select photos and presentations ■

Rajesh Khosla
President AIGMF and CEO/President AGI Greenpac

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GLASS News

KEY INDIAN GLASS INDUSTRY LEADERS VISIT GLASS FUTURES' GLOBAL CENTRE OF EXCELLENCE

Senior management from leading Indian glass manufacturers have visited Glass Futures' Global Centre of Excellence in St Helens, UK, in recent months, strengthening collaboration on innovation, sustainability and industrial decarbonisation.

In October, Mr. Rajesh Khosla, CEO of AGI Glaspac and President of The All India Glass Manufacturers' Federation (AIGMF), visited the facility and toured the world's first openly accessible, commercially available glass melting facility dedicated to research and development, innovation and training. During the visit, Mr. Khosla observed cutting-edge technologies, including an experimental 30 tonnes-per-day pilot furnace, advanced cold end inspection systems, a lehr and roll plate line, and a next-generation IS machine.

AGI described the visit as a 'deep dive into tangible solutions' focusing on how alternative fuels and hybrid furnaces can fundamentally lower the leading container glassmaker's carbon footprint.

AGI's Chief Technology Officer, Mr. Chandramohan Mangalagiri, and Mr. Ajay Joshi from AGI's Research & Development Centre joined the discussions virtually. Key areas explored included sustainable raw materials, carbon capture technologies and value-added functional coatings aimed at enhancing performance while lowering environmental impact.

AGI's Mr. Rajesh Khosla with Glass Futures' Ms. Caroline Hobday and Mr. Dave Fordham in October 2025

The visit followed an announcement in June 2025 when AGI Glaspac became the first Indian-owned company to join Glass Futures' expanding international network of stakeholders that is working together to identify and deliver routes to decarbonise glass production.

In a separate visit in December, Mr. Jeetendra Sehgal, President – Business R&D at Borosil Renewables, toured the Glass Futures facility to explore opportunities for technical collaboration. Borosil Renewables, a world-renowned solar glass manufacturer, continues to play a significant role in supporting the global transition to clean energy through advanced solar glass solutions.

During his visit, Mr. Sehgal witnessed the R&D furnace operating under continuous melting conditions following successful commissioning. The Glass Futures technical team has transitioned to 24/7 operation, running a series of experiments to understand furnace performance under standard conditions. These tests will set the benchmark for future trials with low-carbon alternatives such as hydrogen, biofuels, and hybrid electric boost.

This milestone builds on industrial trials conducted at the end of 2024 and early 2025, during which five different types of liquid biofuels were tested in glass and ceramic production. These trials involved four of the UK's largest glass manufacturers — Ardagh Group,

Mr. Jeetendra Sehgal of Borosil Renewables with Mr. Aston Fuller, General Manager at the 'Glass Futures' facility

Mr. Ajay Joshi, Mr. Rajesh Khosla and Mr. Chandramohan Mangalagiri from AGI alongside Mr. Vinit Kapur (AIGMF) and Mr. Dave Fordham (Glass Futures) at the AIGMF's 15th International Conference in Mumbai on Sept 11

Encirc (part of Vidrala), Pilkington United Kingdom Limited (NSG Group), and O-I — as well as DSF Refractories & Minerals Ltd, the UK's largest shaped refractory producer.

Alongside senior members of the Glass Futures leadership and technical team, discussions were held with Mr. Rajesh Khosla and Mr. Jeetendra Sehgal to explore opportunities for long-term collaboration, knowledge exchange and the deployment of low-carbon technologies. Mr. Dave Fordham, Global Engagement Lead at Glass Futures and member of KANCH's editorial board, participated in both meetings, contributing insights drawn from more than 30 years of engagement with the Indian glass industry.

"I was pleasantly surprised to know that the Glass Futures' furnace is also designed to conduct the real-time refractory corrosion tests. I was not aware about this feature of the furnace earlier." commented Mr. Sehgal after the visit.

The meetings in St Helens followed Glass Futures' participation alongside the AIGMF at the 27th International Congress on Glass (ICG) held in January 2025 in Kolkata and the 15th AIGMF International Conference on 'AI and Digitalisation' during Glasspex India 2025 in Mumbai.

Glass Futures also supported the AIGMF Executive Committee meeting in Goa in November 2024 following a joint announcement with Diageo to expand their partnership into key regions such as India to accelerate decarbonisation pathways for the global glass industry.

www.glass-futures.org
www.agi-glaspac.com
www.borosilrenewables.com

UK GLASS SECTOR OUTLINES STRATEGIC POLICY PRIORITIES AT WESTMINSTER EVENT

The UK Glass & Glazing Collective brought the future of UK-made glass into sharp focus at a special parliamentary event held at the House of Commons on Oct 28 to spotlight the strategic importance of the glass sector in the UK's industrial and net zero future.

Hosted on the Westminster Terrace, the event showcased the critical role of glass and brought together MPs, industry leaders, and policymakers, all united by a shared ambition to unlock the full potential of the UK glass and glazing sector.

The event served as a platform to present a united industry voice and outline key policy recommendations to support the sector's growth and competitiveness within a global economy including decarbonisation, circular economy practices and recycling reforms including pEPR and DRS, low-carbon construction incentives and political stability.

Speakers included Mr. David Baines MP who sponsored the event, Minister for Industry Mr. Chris McDonald, Ms. Sarah Champion MP, Mr. Mike Butterick of the Flat Glass Manufacturers Association, British Glass President Mr. Dean Butler of

Ardagh, Mr. Steven Heath of Knauf Insulation and Mr. Justin Kelly from Glass Futures.

Mr. Dave Dalton, CEO of British Glass, said: *"It was fantastic to see so many people on the Westminster Terrace today to support the UK glass sector in flying the flag for domestic manufacturing and the significant part we play in the UK economy."*

"As a sector we're asking for a fairer and better considered policy environment through which we can stabilise recent declines and re-establish our role in bolstering revenues, maintaining UK manufacturing jobs and leading the technology agenda to make Britain Great again!"

Mr. Justin Kelly, CEO, Glass Futures, added: *"The Glass Collective parliamentary reception was a landmark moment for our industry - the first time we've come together, united across sectors and even among competitors, with a shared voice and clear policy asks. That unity reflects the kind of collaboration essential to delivering industrial decarbonisation at pace."*

"Glass is not just a material of the past - it's a platform for the future. From solar and wind to defence, medicine, and quantum computing, glass underpins the high-growth, high-tech sectors that will shape the UK's economic and scientific future.

But this is also a critical juncture. Without urgent action to level the playing field on energy costs and enable circularity through recycling, we risk losing momentum. With the right support, the UK can lead the world in sustainable materials innovation - delivering jobs, resilience, and global leadership in the technologies that will define tomorrow's world."

The event was organised by the UK Glass & Glazing Collective, a strategic alliance of British Glass, Glass Futures, the Glass & Glazing Federation, and the Worshipful Company of Glass Sellers formed to elevate the sector's voice in government and policy.

The UK Glass & Glazing Collective will continue to engage with government to ensure the sector's priorities are reflected in future industrial and environmental policy.

VSU STUDENTS TAKE PART IN GLOBAL MEET AT MUMBAI

Six students from Vikrama Simhapuri University (VSU) in Nellore got a rare opportunity to participate in the prestigious international conference organised by The All India Glass Manufacturers' Federation (AIGMF) in Mumbai from Sept 10-12, 2025.

N. Lingaraju, P. Harshavardhan, N. Dileep Kumar, G. Mohammad Shabber Hussain, K. Ravishankar Naik and K. Ananth Ram Naik participated in the 'AI and Digitalisation: the future for sustainable glassmaking conference.

"The students shouldered the responsibility of coordination, which helped them in networking with international delegates and gaining direct experience in event management," said Vice-Chancellor (V-C) Prof. Allam Srinivasa Rao.

Later at their University VC Prof. Rao handed over the experience certificates to the students issued by the AIGMF.

AIGMF AT INTRAPAC INDIA 2025

As a supporting Association, AIGMF participated at the IntraPac India 2025, an exhibition on Packaging and Processing organised from Dec 10–13 at India Expo Centre, Greater Noida UTTAR PRADESH.

Organised by the Indian Printing Packaging & Allied Machinery Manufacturers' Association (IPAMA), IntraPac India 2025 featured a

comprehensive range of packaging solutions, machinery, and allied products, Packaging Technologies: Innovations in metal, **Glass,** and paper packaging.

GLASS FUTURES ACHIEVES MAJOR MILESTONE- FIRST GLASS SUCCESSFULLY ROLLED FROM EXPERIMENTAL FURNACE

Glass Futures is proud to announce a significant breakthrough in the commissioning of its world-first experimental glass furnace. At the start of this week, the team successfully rolled the first glass from the furnace, marking a pivotal moment in the journey to deliver a transformative R&D asset for the global glass industry.

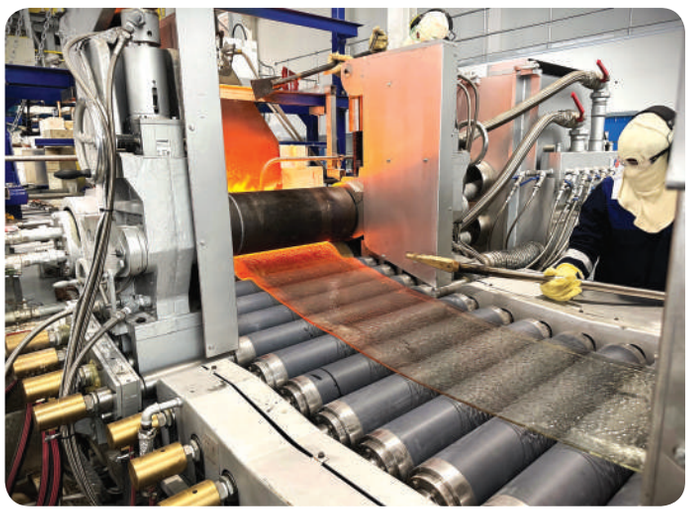
Glass Futures is a global innovation platform that brings together industry, academia, and government to turn ambition into action. At the heart of its pilot facility is an innovative 30-tonne-per-day oxy-fired pilot furnace, designed to showcase sustainable technologies and approaches.

From pioneering the world's first multi-fuel hybrid pilot-scale glass furnace, to enabling circular supply chains and smarter manufacturing, Glass Futures delivers real-world solutions at scale.

This achievement follows months of meticulous planning, engineering, and collaboration. The furnace, lit in June of this year, is designed to enable advanced analysis of glass flow and composition.

After overcoming commissioning challenges, including melting glass in an area near the furnace exit where directing heat is more difficult, the team successfully achieved full commissioning of the furnace and began rolling glass through both the rolled plate line and annealing lehr.

"This is a huge step forward," said Mr. Justin Kelly, CEO of Glass Futures. *"This milestone brings to life the investment in this national research and innovation asset with globally unique innovation capability. Along with the fantastic team at Glass Futures and our members, we are now fully open and actively collaborating."*



Glass Futures will now begin its formal trial programmes, with this milestone paving the way for groundbreaking research and innovation in sustainable glass manufacturing.

Several such pioneering programmes is funded under the UK government's Industrial Fuel Switching (IFS) initiative from the Department of Energy Security and Net Zero. These programmes will explore alternative energy sources such as waste-derived biofuels, electrical boosting, and hydrogen, aiming to revolutionise high-temperature industrial processes and reduce reliance on fossil fuels.

Mr. Aston Fuller, General Manager at Glass Futures said, *"Having been part of Glass Futures since the very beginning, seeing the first glass roll from our furnace is a moment I'll never forget".*

Mr. Fuller added, *"It's the result of years of vision, planning, and relentless hard work from an incredible team. This milestone isn't just about commissioning a line, it's about proving that innovation, collaboration, and perseverance can reshape the future of glass manufacturing and beyond."*

"Witnessing the first piece of glass was an incredible moment for the whole team" said Mr. Andy Pink, Head of Operations at Glass Futures. *"This has been a complex and demanding commissioning process, and I'm immensely proud of the tireless work, resilience, and collaboration that got us here. We've overcome real technical challenges, and while there's still more to do, this milestone proves what's possible when a team of great people come together with a shared purpose."*

RELEASE OF AIGMF 2026 PRINT CALENDAR ON THE THEME 'GLASS IS PURE'

Parallel to the Container Glass promotion meeting of the AIGMF, the annual calendar for 2026 was unveiled on the theme 'Glass is Pure' or कांच जीवन है on Dec 24 at AIGMF Secretariat carrying best entries from the 2025 Youth contest.

To commemorate International Youth Day, The All India Glass Manufacturers' Federation (AIGMF) invited online entries from the age group between 7-24 years to participate in the contest themed 'Glass is Pure'.

Winners were given cash prizes. And later the entire project was converted into the 2026 Calendar by using their creatives and poems.

INSPIRING YOUNG MINDS AT GOLD PLUS: A GLIMPSE INTO THE FUTURE OF GLASS

Gold Plus Glass Industry Ltd., recently had the pleasure of welcoming students from Kanya Mahavidyalaya College, Jalandhar PUNJAB to its Roorkee manufacturing facility, offering them an immersive insight into the science, technology, and innovation behind modern glass manufacturing.

During the visit, students gained hands-on exposure to the float glass manufacturing process, explored various types of glass, and understood the applications and performance advantages of specialized products like silver mirrors. The experience bridged classroom learning with real-world industrial practices, sparking curiosity and encouraging scientific thinking.

As these bright young minds looked beyond the glass, they caught a glimpse of a future where science, sustainability, and creativity converge. Their enthusiasm mirrored the very spirit of innovation that drives Gold Plus every day—shaping not just glass, but the leaders of tomorrow.

In addition to the plant tour, the students attended a technical presentation conducted by Gold Plus experts, providing a structured understanding of the applications of glass across architecture, automotive, interiors, and infrastructure. The session also covered the processing of glass, including cutting, toughening, coating, and silvering, highlighting how raw float glass is transformed into high-performance products. Further, students were introduced to the diverse career opportunities within the glass industry, spanning research and development, production, quality control, sustainability, engineering, and design—offering valuable insight into how innovation and expertise shape the future of this dynamic sector.

This visit resulted as part of the commitment laid on March 8 at the AIGMF's International Women's Day at Kaziranga in 2025 where ICG Mentor Prof. Arun Varshneya guided the Industry to take lead in empowering women in glass manufacturing.

के.एम.वी. की छात्राओं का गोल्ड प्लस फ्लोट ग्लास इंडस्ट्री, रुड़की में हुआ इंडस्ट्रीयल अनुभव।

कन्या महाविद्यालय (स्वायत्त) अपने विद्यार्थियों को अनुभवात्मक शिक्षा प्रदान करने में निरंतर उत्कृष्ट प्रदर्शन कर रहा है। आटोनेमी के अंतर्गत के.एम.वी. ने अपने सिलेबस को निरंतर अपडेट किया है, जिसमें औद्योगिक प्रशिक्षण एवं व्यावसायिक ज्ञान को पाठ्यक्रम का अभिन्न अंग बनाया गया है। इसी कड़ी में एम. बी.ए., एम.सी.ए., कॉमर्स और फिजिक्स विभाग की छात्राओं ने गोल्ड प्लस फ्लोट ग्लास इंडस्ट्री, रुड़की का दो दिवसीय शैक्षिक एवं औद्योगिक दौरा किया। यह संपूर्ण यात्रा उद्योग द्वारा स्पांसर्ड थी, जिसमें प्रतिभागियों के ठहरने की व्यवस्था भी सम्मिलित थी। यह पहल के.एम. वी. और ऑल इंडिया ग्लास इंडस्ट्री के सहयोग का परिणाम है। यह दौरा छात्राओं के लिए अत्यंत ज्ञानवर्धक रहा, जिसमें उन्होंने कांच निर्माण की संपूर्ण प्रक्रिया को प्रत्यक्ष रूप से देखा। कच्चे माल की भट्टियों में प्रोसैसिंग से लेकर तैयार उत्पाद की पैकेजिंग तक। छात्राओं ने फ्लोट ग्लास और फ्रॉस्टेड ग्लास के निर्माण की

अत्याधुनिक तकनीक को समीप से देखा और सीखा।

इस समृद्ध अनुभव ने कक्षा में प्राप्त सैद्धांतिक ज्ञान और वास्तविक औद्योगिक प्रक्रियाओं के बीच एक सशक्त सेतु का निर्माण किया। भौतिक विज्ञान की छात्राओं ने जहां कांच के पदार्थ विज्ञान और प्रकाशीय गुणों का अध्ययन किया, वहीं एम.बी.ए. की छात्राओं ने बड़े औद्योगिक संस्थान के प्रबंधन, लॉजिस्टिक्स और मार्केटिंग पहलुओं को समझा। समूह का स्वागत गोल्ड प्लस ग्लास इंडस्ट्री की जनरल मैनेजर (मार्केटिंग) सुश्री शीतल खन्ना ने किया।

MANI P S SAYS GOODBYE AFTER 27 YEARS WITH SAINT GOBAIN

With four decades of corporate experience, including 27 years with the Saint-Gobain Group INDIA, Mr. Mani P S, a seasoned business leader known for building markets, nurturing people, and creating long-term value through purpose-driven leadership retired from Saint Gobain India operations.

Mr. Mani's professional journey has been deeply anchored in the glass and building materials ecosystem, where he played pivotal roles across sales leadership, strategic growth, channel development, capability building, and organizational transformation. At Saint-Gobain India, he has contributed significantly to the evolution of the glass business—strengthening distribution networks, deepening customer engagement, enabling high-performance teams, and embedding a culture of ethics, inclusion, and continuous improvement.

A defining strength of Mr. Mani's leadership has been his ability to balance business performance with people development. Over the years, he has mentored and coached professionals across levels, helping them navigate leadership transitions, manage complexity, and build confidence in decision-making. His leadership philosophy rests on clarity of purpose, disciplined execution, and respect for people—believing that sustainable results emerge when individuals feel valued, trusted, and challenged.

Beyond corporate roles, Mr. Mani has been a strong advocate of industry–academia collaboration. Through his active involvement with Glass Academy, he has enabled partnerships with engineering colleges, polytechnics, and architecture institutions—bringing real-world industry exposure into classrooms. These initiatives reflect his conviction that employability, skill development, and industry relevance must go hand in hand.

As he transitions into his second innings, Mr. Mani is the Founder of Kalpavriksha—a platform envisioned as a space for coaching, mentoring, advisory, and leadership conversations. Through Kalpavriksha, he works with entrepreneurs, family-run businesses, senior leaders, and young professionals—helping them build clarity, strengthen communication, manage change, and grow with purpose. The name reflects his belief in being a "giving tree"—offering experience, perspective, and wisdom gained over decades.

Mr. Mani is reachable at maniseshanps@gmail.com

IRAN SHOWCASES GLASS INDUSTRY SELF-SUFFICIENCY AT TEHRAN EXHIBITION

The 8th International Glass and related equipment exhibition was successfully held from January 2-5, 2026, at the Tehran Permanent Fairground. This year's edition marked a significant milestone, witnessing a remarkable increase in participation from both domestic and international exhibitors. The event also saw a record-breaking turnout of visitors, reflecting the dynamic growth and innovation within the glass industry.

Iran produces crystal and decorative glass of high quality standards to the point of competing with well-known foreign brands, including Czech crystal, and are now active exporters. The exhibition aimed to support domestic producers, expand international trade ties, create investment opportunities and boost foreign currency earnings, while strengthening cooperation across the glass industry value chain.

(News Source: AIGMF Research Team / World Wide Web)

Mr. Saeed Keshavarz (second from right) AIGMF's friend and RO17 (India and Iran) Member for IYoG 2022 at the Iranian Trade Fair

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INTERNATIONAL GLASS MANUFACTURING SHOW

IGMS 2026

From Sand to Hand

DUBAI
21–23 April

Media Partner: AIGMF since 1944

Glass is more than a material — it is the surface that shapes our skylines, brightens our homes, and drives innovation in smart cities. From timeless façades to cutting-edge technologies, glass tells the story of progress.

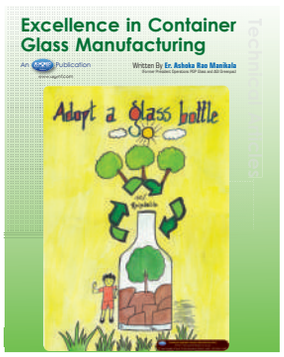
The International Glass Manufacturing Show (IGMS 2026) celebrates this journey. Taking place in Dubai (21–23 April) , IGMS is the onlyevent in the Middle East that brings together the entire glass industry — from raw materials and machinery to the latest in smart and sustainable solutions.

Exhibitors from around the world will showcase innovations, while architects, developers, and buyers discover the products shaping tomorrow's projects. It is a place where business meets inspiration, and where global opportunities connect with regional ambition.

At IGMS 2026, the journey of glass — from sand to hand — comes to life.

glass-show.com
info@glass-show.com

Introduction to Container Glass Manufacturing (chapter 1 of 15)



PROCESS OF CONTAINER GLASS MANUFACTURING (FIG. 1.1)

Container glass manufacturing process looks very simple, but in practice it is highly complicated. Good process control and good quality control from receiving raw materials to usage of bottles at customer end is very important as there are many variables in raw materials, process parameters and storage conditions which can impact bottles end performance. Hence, top class quality control in every stage is very important in container glass manufacturing. The investment cost, raw material cost, operation costs and plant output & quality are very important factors, which decides the profitability of the manufacturing facility. It is advisable to thoroughly study all the aspects before setting up glass business as there are many businesses that went into loss due to lack of understanding the market conditions and production requirements.

To set-up container glass industry, following factors/ requirements, must be thoroughly reviewed and evaluated:

1. Availability of quality raw materials at nearby places
2. Customer locations
3. Availability of fuel / gas, electricity and water
4. Connectivity by air, sea and road
5. Availability of land
6. Availability of skilled manpower
7. Seismic conditions
8. Local / state / country policies

For example, to set up a 500 TPD container glass Industry, some requirements are:

Approximate land required: For factory and warehouses: 20 Acres (40% land reserved for greenery)

Investment: INR 750 Cr / USD 90 Million (approximate cost in South East Asia & Middle East and it can vary based on type of equipments, automation levels, glass type)

Production building size required: 12,000 Sq. mtr (each floor, 2 floors required)

Batching plant size required: 1200 Sq. mtr x 4 floors (25 mtr high)

Gas / fuel per day: Natural gas- 100,000 SCM / day

Electricity: 110KV / 132KV, 12 MW

Water: 300 KL/day

Major raw materials required / day @ 30% cullet: Cullet – 150 T (tons), silica sand- 240 T, soda ash – 80 T, lime stone – 50 T, dolomite – 20 T, feldspar-25 T

Resources availability: All major raw materials like cullet, silica sand or quartz, lime stone, dolomite and feldspar should be available preferably within 100 kms to have lower transportation cost. Basic RM cost in many cases is low but transport cost may lead to higher cost of RM when delivered to factory. Hence setting-up the Glass plant near main raw material source is advantageous. Fuel or natural gas should also be available at close distance.

Customer Locations / Delivery: For reducing transport cost, it is preferred to have 80% of customers within 500 kms or there should be a well-connected shipping arrangement.

1.0 Container Glass manufacturing process: Figure

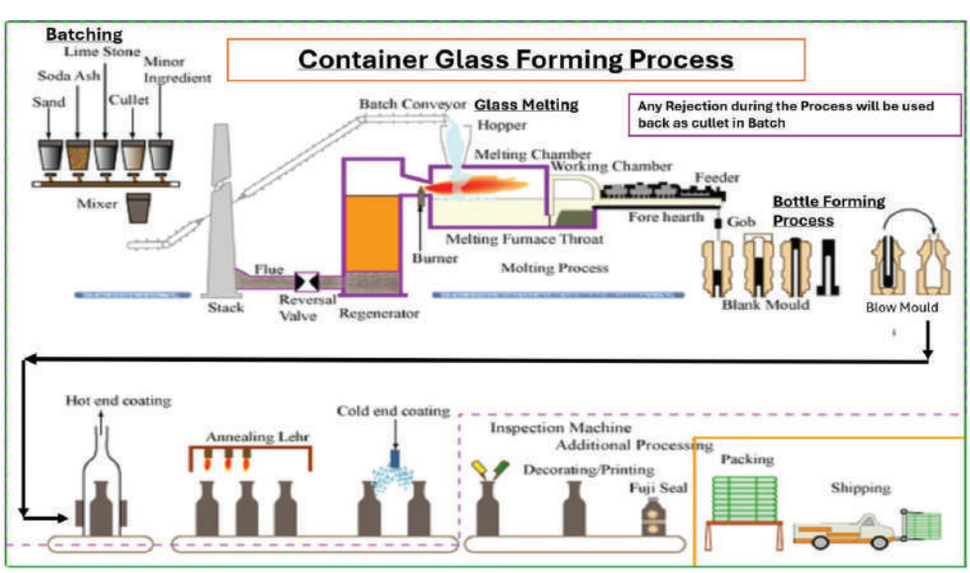


Figure 1.1

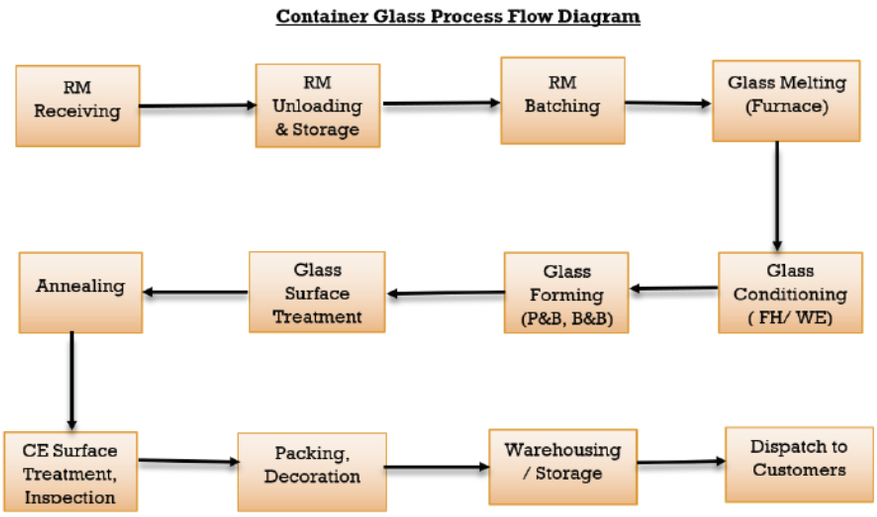


Figure 1.2

1.2 shows the process flow sheet of container glass manufacturing.

1.1 Introduction to Glass: Before delving into container glass manufacturing, it is important to understand the general properties of glass, types of glass and its uses.

Glass is an amorphous (non-crystalline) solid. Because it is often transparent and chemically inert, glass has found widespread practical, technological, and decorative use in window panes, tableware, containers and optics.

1.1.1 Difference between crystalline and non-crystalline structures (Figure 1.3)

a. Arrangement

Crystalline solids have a regular, repeating three-dimensional arrangement of their atoms, ions, or molecules. Non-crystalline solids, also known as amorphous solids, have a random arrangement of their atoms.

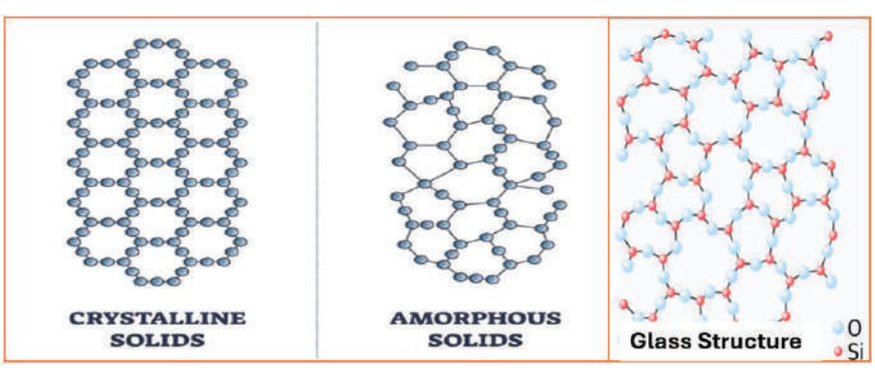


Figure 1.3

b. Physical properties

Crystalline solids have well-defined edges and faces, and a sharp melting point. Non- crystalline solids have irregular or curved surfaces, and melt over a wide range of temperatures.

c. Applications

Crystalline solids are used in lasers, optics, high energy physics, biomedical technology, and light emitting diodes. Non-crystalline solids are used in glasses, amorphous semiconductors and metals, and sol-gel materials.

d. Examples

Quartz is a common example of crystalline silica, while glass, silicon carbide, and silicone are examples of non-crystalline silica. Non- crystalline candies, such as hard candies, caramels, toffees, and nougats, are chewy or hard. Crystalline candies, such as fondant and fudge, are smooth, creamy, and easily chewed.

1.2 Glass classification: Glass is classified into many types based on applications, market sectors, raw materials used and based on treatment applied on glass.

1.2.1 Glass classification based on applications: Refer below details.

Glass classification based on Applications

Application	Description
Flat glass	Used for windows, doors, mirrors, and other architectural applications
Automotive glass	Used for windshields, side windows, and rear windows in vehicles
Display glass	Used for screens in televisions, computers and mobile devices
Container glass	Used for containers for food, beverages and pharmaceuticals
Fibre glass	Used for insulation, reinforcement and composite materials
Solar glass	Used for photovoltaic panels to generate electricity from sunlight
Optical glass	Used for lenses, prisms and other optical components in scientific and industrial applications
Safety glass	Used for applications where safety is a concern, such as tempered glass for shower doors or laminated glass for windshields
Decorative glass	Used for artistic and decorative purpose, such as stained glass windows or glass art installations
Medical glass	Used for laboratory equipment, medical devices and implants

1.2.2 Glass classification based on market sectors:

Glass Type	Description
Flat glass	Used in buildings (windows and facades) and automotive industries (windscreens, side and rear-side glazing, backlights and sunroofs). Flat glass is also used in solar-energy applications (photovoltaic and solar thermal panels) as well as in urban and domestic furniture, appliances, mirrors and greenhouses; almost all flat glass is made by means of the float process.
Container glass	Used in food, liquor, soft drinks packaging, pharmaceutical applications, cosmetics and perfumery containers (flacons).
Continuous filament glass	Light weight components for flights, automotives, wind turbines, fans etc., for many industrial uses and as insulation material, fiber glass material etc.
Domestic glass	Used for tableware, cookware and decorative items such as drinking glasses bowls, plates, vases and ornaments.
Special glass	Lighting glass, glass tubes, laboratory glassware, glass ceramics, heat-resistant glass, optical and ophthalmic glass, extra thin glass for the electronic industry such as liquid crystal display (LCD) panels, photovoltaic and radiation protection glasses.

1.2.3 Glass Types based on raw materials used: Based on raw materials used, glass is usually classified into three main classes:

Soda lime glass

- It is obtained from the fusion of a mixture of silica, lime, soda and alumina.
- Soda lime glass cullet too may be used.
- This glass is also termed as Soda-lime- silica glass.
- It is used for glazing doors, windows and making ordinary glass wares.

Lead Glass

- It is obtained from the fusion of a mixture of silica, lead and potash.
- Powdered glass / cullet, too may be added.
- This glass is also termed as Lead crystal glass.
- Lead glass has highly shining appearance.
- It is not affected by temperature.
- Cut glass work, electric bulbs and optical glass are made from it.

Borosilicate glass (Type I Glass)

- It is obtained from the fusion of a mixture of silica, borax, lime, and feldspar.
- Borosilicate glass cullet too may be added.
- This glass withstands high temperature.
- Laboratory equipment and kitchen utensils are made out of it.

1.2.4 Glass types based on treatments Certain treatments make glass suitable for various applications. The types of glass based on certain treatments are:

1. **Normal annealed glass:** Most glasses are normal annealed glass and they break with impact. Normal sheet glasses, container glasses are annealed after forming.
2. **Tempered glass:** Tempered glass is a type of glass that is heated to a high temperature and then rapidly cooled. The process makes the glass stronger than regular glass and resistant to impact. Tempered glass is used in car windows, shower doors, and other applications where safety is paramount.
3. **Laminated glass:** Laminated glass is made by sandwiching a layer of polyvinyl butyral (PVB) between two or more layers of glass. The PVB layer acts as an adhesive and helps to hold the glass together in case of breakage. Laminated glass is used in car windshields, skylights, and other applications where safety is critical. Bulletproof glass is also made from laminated glass of many layers.
4. **Insulated glass:** Insulated glass is made by sandwiching two or more panes of glass with a spacer between them. The spacer creates a gap between the glass panes, which is filled with air or gas. The insulating effect of the spacer reduces heat loss, making insulated glass an energy-efficient option. Insulated glass is used in windows and doors in homes and buildings.
5. **Low-E glass:** Low-E (low emissivity) glass is a type of glass that has a thin metallic coating on one side. The coating helps to reflect heat and light, making it an energy-efficient option. Low-E glass is used in windows and doors in homes and buildings.
6. **Mirrored glass:** Mirrored glass is made by coating one side of the glass with a reflective material such as aluminium. Mirrored glass is used in mirrors, decorative items, and security applications.

7. **Tinted glass:** Tinted glass is made by adding a color to the glass during the manufacturing process. Tinted glass is used in windows, doors, and other applications to reduce glare and heat gain.
8. **Wired glass:** Wired glass is a type of glass that has a wire mesh embedded in it. The wire mesh helps to hold the glass together in case of breakage, making it a popular option for fire-rated doors and windows. Wired glass is also used in skylights, greenhouses, and other applications where safety is critical.
9. **Type II glass:** This is the container glass type treated internally to increase chemical resistance of glass.

1.3 Glass uses

The glass is one of the early discoveries of man. It was made out of molten sand, and since then, it has become indispensable. There are no alternatives to it in some cases. Its applications to man include:

1. **Containers / Bottles:** Glass bottles are used for filling various products like jam, beer, liquor, beverages, chemicals, pharmaceuticals etc.

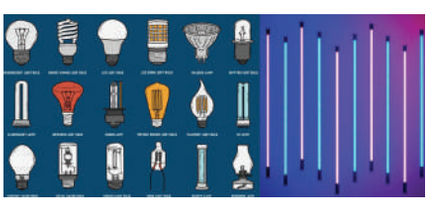
2. **Kitchenware:** Glass is used in kitchen as containers, plates, in microwaves and tumblers.

3. **Building materials:** Sheet glass is used in buildings, structures, bridges.

4. **Eyeglasses and lenses:** Glass is used in manufacturing eye lenses, camera lenses, microscopes and binoculars.

5. **Electronic screens, TVs:** Glass used in LCDs, LCD screens for display, laptops, computers.

6. **Lights and bulbs:** Glass is used for making bulbs, tube lights.



7. **Automobiles, aeroplanes:** Glass is used in wind shields of vehicles, window glasses and also in aeroplanes.

8. **Laboratory appliances:** Glass made from borosilicate glass is used for laboratory appliances like beakers, burettes, pipettes and funnels etc.

9. **Reinforced fibreglass material:** Glass is used as fibre glass to make many components like boat bodies, ship parts, wind power turbine blades & components, aeroplane bodies.

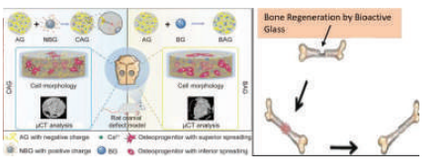
10. **Solar panels:** Glass is used widely in solar panels and market demand for solar panels is increasing now a days.

11. **Insulation material:** Insulating material uses fiber glass and it finds wide applications in building constructions, industrial pipes and vessels insulation.

12. **Communication optic cables:** Fibre optic cables use glass core and glass cladding.

13. **Medical & dental applications:** Bio-active glass is used in dental applications, medical applications

for bone and other parts for regeneration.



Glass finds its use in many areas and its demand is increasing. In this book we will discuss mainly about container glass manufacturing process.

1.4 Types of container glass: Again, the container glass can be classified based on raw materials used, glass specification, sectors for which glass is used and glass colours.

1.4.1 There are basically 3 types of glass used for container glass manufacturing, based on raw materials

They are:

1. Soda-lime-silica glass
2. Borosilicate glass
3. Lead glass

Soda-lime-silica glass: Soda lime silica glass is the most common glass used for making container glass, sheet / flat glass, bulbs & tubing with slight changes in composition for each of them. Approximately more than 90% of glass produced are soda- lime-silica glass.

Borosilicate glass: This is known as Type I glass. It is mainly used for pharmaceutical applications (vials), laboratory purposes where high temperature and high resistance to chemical attack is required.

Lead glass: This glass is typically used for table ware or lead crystal glass, produced using traditional hand working methods. The composition provides wide working range and gives sparkling appearance to the finished product.

1.4.2 Container glass Types based on specification / surface properties

Container glass means all type of glass bottles and jars used for beverages e.g. juices, soft drinks, carbonated drinks, pharmaceutical, cosmetics, perfumes and foods. Glass containers are mostly intended to come into direct contact with the inside content. Therefore, they must comply with their respective specifications for identity and surface hydrolytic resistance. Container glass is generally classified as Type I, II and III glass.

In addition to the above glass Types, there is also Type 4 Glass which contains higher alkali content & has lower hydrolytic resistance. Other notable categories include lead crystal and special alumino silicate glasses. Special aluminosilicate glass is emerging as very high-performance pharmaceutical glass.

Glass used for container glass is either soda- lime-silica glass or borosilicate glass (neutral). Soda-lime-silica glass has a moderate hydrolytic resistance due to the chemical composition of the glass itself; it is classified as Type III. Suitable treatment of the inner surface of Type III soda-lime-silica glass containers will raise the hydrolytic resistance from moderate to a high level, changing the classification of the glass to Type II. Borosilicate glass contains significant amounts of boric oxide, aluminium oxide, alkali and/or alkali earth oxides. Borosilicate glass has a high hydrolytic resistance and high thermal shock resistance due to chemical composition of the glass itself; it is classified as Type I. Now let us study in details, each type of container Glass and their applications.

1. Type I Glass

Type I borosilicate glass is the gold standard in pharmaceutical packaging, primarily due to its exceptional material properties. Characterized by its low thermal expansion co-efficient, this glass type exhibits remarkable stability under temperature fluctuations. This stability is crucial in environments where drugs are exposed to varying temperatures, ensuring that the integrity of the glass remains intact. Also, its high resistance to chemical attack, makes it an ideal candidate for storing a wide array of pharmaceutical products. Whether the contents are acidic, neutral, or slightly basic, Type I borosilicate glass ensures minimal interaction, preserving the purity and efficacy of the medication. Its use in vials, ampoules, and containers for injectable drugs is widespread, as these applications demand the highest level of chemical inertness to prevent any potential drug-container interactions. The ability of Type I borosilicate glass to maintain the chemical composition of medications unaltered is invaluable for pharmaceutical companies.

2. Type II Glass

Type II glass offers an excellent balance of affordability and safety. As a treated form of soda-lime glass, it undergoes a surface treatment process known as de-alkalization. This process significantly reduces the glass's alkali content on inside surface of the glass, enhancing its chemical resistance compared to untreated soda-lime glass. Although it doesn't reach the heights of chemical resistance seen in Type I glass, Type II glass still offers sufficient protection for less sensitive pharmaceutical preparations. It is an excellent choice for oral medication bottles and containers where the risk of chemical interaction is moderate. The cost-effectiveness of Type II glass also makes it a popular option, particularly in scenarios where the stringent requirements for Type I glass are not necessary. This Type of glass is often used in situations where budget considerations are as crucial as the packaging's protective properties, providing a practical solution for a wide array of pharmaceutical applications. Type II glass is also used

for packing of high-end beverages, liquors, chemicals and water bottles. The process of making Type II glass is explained in detail in separate chapter.

3. Type III Glass

Type III regular soda-lime glass is a widely utilized material in the pharmaceutical industry, particularly for non-critical applications. While less resistant to chemical attacks than Type I or II glasses, its composition is perfectly suited for packaging products where strong chemical resistance is not a primary concern. This makes it an ideal choice for non-aqueous products like tablets, capsules, and powders. The affordability of Type III glass is one of its most appealing attributes, offering a cost- effective solution for large-scale packaging needs. Its application is most common in products where the interaction between the medication and its container is less likely to compromise the medication's effectiveness.

4. Type IV Glass

Type IV glass is a category of general-purpose soda-lime glass used in the pharmaceutical industry. This Type of glass is not as chemically resistant as Types I or II, and it's typically used for packaging products where the contents do not directly interact with the glass or are not highly sensitive to the container material.

The primary advantage of Type IV glass is its flexibility and cost-effectiveness, making it suitable for a wide range of non-parenteral products such as oral liquids, topical creams, and ointments. While Type IV glass does not offer the same level of protection against leaching as borosilicate or treated soda- lime glasses, it is still a viable option for many pharmaceutical applications. Its use is generally preferred in scenarios where the risk of chemical interaction is minimal, and the primary requirement is a practical, economical packaging solution. Because of its versatility, Type IV glass is the leading choice for less critical pharmaceutical packaging needs.

5. Aluminosilicate Glass

Aluminosilicate glass is emerging as a high- performance contender in pharmaceutical packaging. Characterised by its exceptional strength and durability, this Type of glass is particularly suited for medications that demand an extra layer of protection. Its robust nature makes it an ideal choice for prefilled syringes, cartridges, and other containers where the risk of breakage must be minimized. The increasing demand for more resilient packaging solutions in the pharmaceutical industry has put aluminosilicate glass in the spotlight, signalling a shift towards materials that can provide enhanced security for high-potency drugs.

1.4.3 Container glass classification based on segments

1. **Perfumery bottles:** These bottles are generally Type III bottles but with high clarity & good surface finish. These bottles are decorated by coating & printing.
2. **Pharmaceutical:** These bottles can be from any Type of soda lime, borax and aluminosilicate glass depending upon the inside glass surface alkali resistance requirement for the particular pharmaceutical products to be filled.
3. **Liquor:** Generally, Type III bottles are used however in certain cases where the taste and properties are main concerns, Type I and Type II glass bottles are also used.
4. **Carbonated drinks:** Carbonated drinks are generally Type III bottles.
5. **Food:** Type III Glass is used in majority cases for food packaging but for certain application, speciality or Type II glass is also used.
6. **Chemical:** As the bottles are used for laboratory chemicals packaging, any small deviation in quality can be a concern. Hence Type II glass is generally used.
7. **Specialty bottles:** These are for special applications like perfume, liquor, food and water filling where high quality of glass surface and glass clarity is required. Bottles are generally Type III flint glass having low iron content in glass. In special cases, Type II treatment is applied to bottles.
8. **Water bottles:** Type III soda lime glass is generally used but for alkaline water or high-quality water, Type II treated glass is used.

1.4.4 Container glass classification based on glass colour: The bottles are classified into five categories. In this category, flint or super flint, amber and green (including light green and champagne green) can be made directly from furnace and others are by adding coloured glass frits into glass in forehearths or by coating the colours on flint bottles in decoration plants.

1. **Flint and super flint:** In market, 60% of bottles are flint or super flint bottles. They are generally used in all market segments.
2. **Amber:** Its main use is in pharmaceutical and beer filling but in few cases it used for liquor, food and perfume filling.
3. **Green:** Used for carbonated drinks, liquor and wine segments.
4. **Coloured bottles:** Used for high end filling requirements for liquor, water, perfume and wine filling.

5. **Coated bottles:** Mainly used for filling perfumes and high-end liquor, water bottles.

1.5 Embracing the future of container glass

The glass industries are striving to develop various glass types to meet the packaging requirements for many applications. From the highly resistant Type I glass to the economical Type IV glass, each type serves a specific purpose, ensuring that products are stored and delivered in the safest and most effective manner possible. The evolution of glass technology for packaging requirements continues, promising even more advanced and secure solutions in the future.

1.6 Glass raw materials and oxides

Over 90% of container glass produced are from soda-lime-silica glass. So, in this book, we will study about soda-lime-silica glass. We will look at general composition of borosilicate Type I glass and lead glass.

1.6.1 Major raw materials used in container glass manufacturing are:

a. **Pure silica (SiO_2, fused quartz)** represents 70-74% weight of modern glass. In ancient times, glassworkers prepared recipes with more than 90% of pure silica, but because this substance has a melting point of about 2000 degrees centigrade (3600° F) chemist found a way to lower that temperature by introducing various additives into the mix, most notably sodium carbonate. One of the most interesting features of pure silica glass is its ability to block UV radiation, which modern 70-72% silica glass can't do.

b. **Sodium carbonate (Na_2CO_3) (soda ash)** represents important ingredient of modern glass that adds both positive and negative features. It successfully lowers the melting point of silica to more manageable 1200°C but it also makes the glass water soluble.

c. To prevent glass from being water soluble and to increase its chemical structure, **lime (calcium oxide, CaO), magnesium oxide (MgO) and aluminum oxide (Al_2O_3)** are added. Glass enriched with lime represents over 90% of the glass that is used today.

d. Addition of **lead oxide, barium and lanthanum oxide** can increase glass refractive index, making it more reflecting and suitable for optical purposes (eyeglasses and lenses). **Thorium oxide** served a similar role in the past, but it was phased out from manufacture because of its radioactivity.

e. **Sodium sulphate, sodium chloride, or antimony oxide** can be added to prevent the creation of air bubbles in the glass mixture. These are for refining the glass during melting.

f. Cerium (IV) oxide is responsible for absorbing UV radiation.

g. Boron oxide (Borax) is one of the main ingredients in so called Pyrex glass. Its ability to strengthen the structure of glass and protect it from thermal expansion, cracking and thermal shock makes it perfect for production of many kitchen cookware, optical component, Type I vials bottles and reagent bottles.

Major raw materials and % of oxides in them			Oxides in glass	
Raw material	**Oxides**	**(%)**	**Oxides range min (%)**	**Oxides range max (%)**
Quartz sand (Silica)	SiO_2	Min 98	71	73
Soda ash	Na_2O	Min 53	12	14.5
Lime stone	CaO	Min 50	9.25	10.75
Dolomite	MgO	Min 18	0.9	2.50
Feldspars (Silica+ Alumina+ Potash)	SiO_2 Al_2O_3 K_2O	Min 65 Min 15 Min 50	1.20 0.00	1.90 1.50

1.6.2 Glass oxides and their properties (Fig. 1.4)

1.6.3 Oxides are classified into following categories:

- **Network forming oxides** – SiO_2, B_2O_3, P_2O_5, GeO_2 – Non-oxide components: fluorides, halides, chalcogenides (As_2S_3, GeS_2)
- **Network modifying oxides** – Na_2O, K_2O, Li_2O, CaO, BaO, MgO, SrO
- **Intermediate oxides** – Al_2O_3, PbO, ZnO, ZrO_2
- **Fining agents/redox active components – sulphates:** Na_2SO_4, $CaSO_4$ – Oxides: As_2O_3, Sb_2O_3, CeO_2 – Chlorides: NaCl – Nitrates: KNO_3, $NaNO_3$ - Carbon
- **Fluxing agents** – CaF_2, spodumene (lithium raw material), blast furnace slags/ calamite
- **Colouring agents** – Fe_2O_3, Cr_2O_3, CoO, Mn_2O_3, Se, Fe_3^+/ S_2^-, rare earth oxides, sulfides, selenides

The glass is not a single compound. It

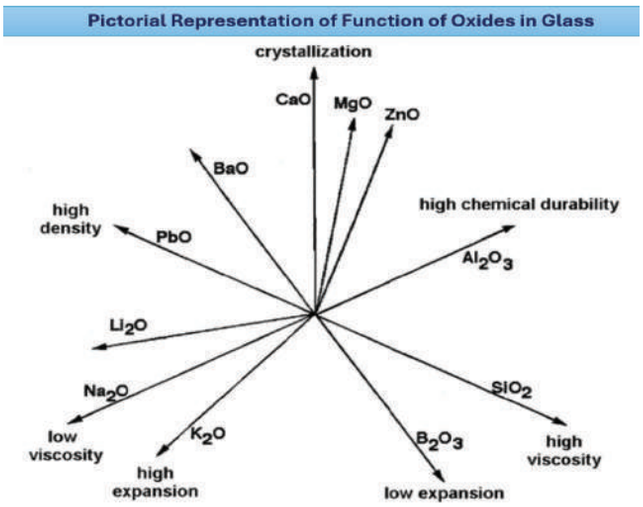


Figure 1.4

is therefore very difficult to give any particular chemical formula for it. But with reasonable accuracy, it may generally be expressed as follows – $aX_2O.bYO.6SiO_2$

Where, a and b are numbers of molecules,

X = an atom of an alkali metal such as Na, K, etc.

Y = an atom of a bivalent metal such as Ca, Pb, etc.

1.7 History of Container Glass Manufacturing

Glass is one of the oldest materials dating back to 3500 BC. Egyptians manufactured the first hollow glass container in 1500 BC, and the invention of the blowpipe in the first century BC was considered a technological revolution. The true revolution, however, was the automatic bottle blowing machine invented in the USA by Michael Joseph Owens at the beginning of the 20th century. Owens was a mechanical genius who began to work on various inventions that would earn him 49 patents. His efforts eliminated child labor in the glass industry. The most important invention was the automatic bottle blowing machine (Fig. 1.5), consisting of 9000 separate parts and developed from 1895-1904. He also later helped produce continuous flat sheet glass. His name has been associated with multiple companies, including Libbey-Owens-Ford, Owens-Illinois and Owens Corning. Its ability to manufacture 30,000 containers per day, made glass container production possible on an industrial scale. His machines could produce glass bottles at a rate of 240 per minute, and reduce labor costs by 80%.

The technology continued to be improved over time, and in 1924, the first Individual Section (IS) machine was developed by Hartford-Empire company (Now Bucher Emhart) enabling each section to produce one or more containers independently. This IS machine was developed by glass-making pioneer Henry W. Ingle of Hartfort-Empire company and emerged as a game-changer. Unlike its predecessors, this machine featured a stationary working table, with molds performing automatic opening and closing actions.

By 1930, advancements such as changing the plunger to a blow head resulted in the Press-and-Blow method for manufacturing large-mouth bottles. In the 1960s, German glassworks like HEYE Glass further refined the process. It evolved to support single, double, and triple gob delivery, with the IS machine adopting both Blow-and-Blow (B&B) (for small-necked bottles) and Press-and-Blow (P&B) (for large-necked bottles) methods. The IS style machines used 'blow and blow'' or "press and blow" techniques that are still applied today. Using these processes, a specific amount of melted glass or a "gob"—falls in a blank mold where it is either blown or pressed with a plunger in first stage and then it is (Parison) is deposited into a finish mold where blowing is completed. Over the time, subsequent innovations led to the creation of variations like the Automatic Milk Bottle Machine, Automatic Press-and-Blow Machine, Lynch Bottle Machine, and Roirant Bottle Machine. These machines shared a common feature - the mould rotation with the working table.

Nowadays, forming machines can have single machines up to 12 individual sections or 24 section tandem machine (12x2, tandem machine) each producing one to six containers simultaneously. This means that one to six gobs of melted glass fall in one to six moulds present in each section, which occur in parallel in each section. Depending on the container's size and shape, the production speed can be as fast as 800 containers per minute.

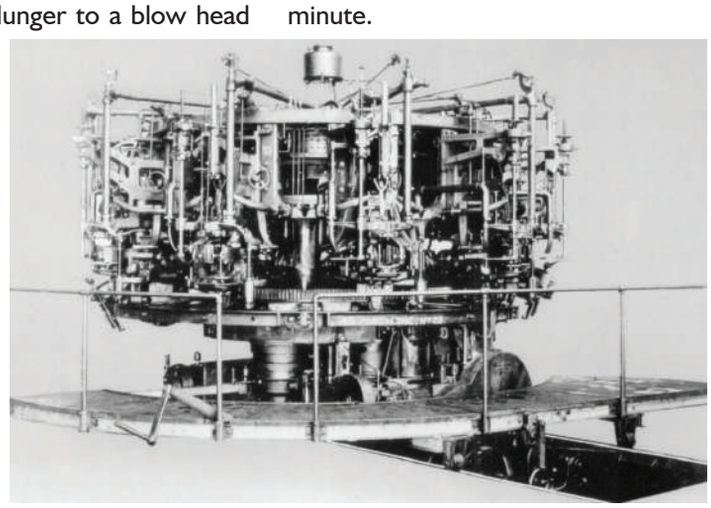


Figure 1.5

1.7.1 Figure 1.6 shows the IS machine of 1925 and present

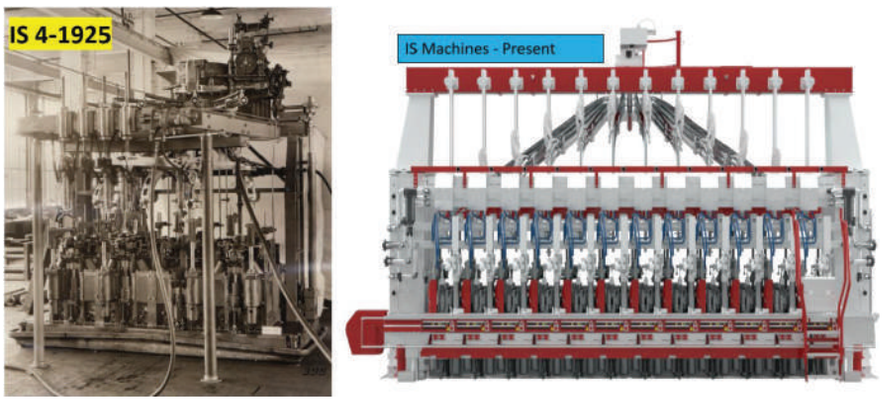


Figure 1.6

1.8 Container glass manufacturing: Glass Manufacturing involves inspection of RMs, storage & batching, melting & conditioning, forming, annealing and inspection.

Once the RMs are tested and accepted, they are stored in batch house silos. Then, as per the recipe, the batch is prepared and fed to melting furnace continuously where the batch is melted at around 1560°C. The molten glass is then refined and conditioned. The conditioned glass in the form of gob is fed to IS Machine where it is formed into bottle by B&B or P&B process. The formed bottle is then passed into an annealing lehr for removing internal stresses. Before the bottle enters the annealing lehr, if required hot end coating, internal Type II treatments are applied. After the annealing bottle is passed through cold end coating process if required. Then the bottle is passed for inspection and packing. If required, the packed bottle is subjected to decoration as per customer requirement or as it is, it is sent to customers.

1.9 Glass forming techniques

Container glass is formed in two stages namely blank side (stage 1) and blow side (stage 2). Bottles are two Types- narrow neck bottles and jars. Generally narrow neck bottles, having neck bore up to 28mm are produced using B&B process and bigger mouth diameter bottles (jars) are formed by P&B process (Fig. 1.7).

P&B bottles will have more uniform thickness compared to B&B process as pressing in first stage make the parison (1st stage bottle) wall thickness more uniform compared to blowing in B&B process. There is a latest process known as NNPB (Narrow Neck Press & Blow), where in 1st stage the narrow neck bottles are pressed and then blown in 2nd stage (Fig. 1.8).

There are many advantages of NNPB process, which is explained in container glass forming chapter.

Container glass like tumblers and table wares are produced by manual or auto press machine (Fig. 1.9).

1.10 Challenges in container glass industry: Challenges can be classified into two categories, internal and external. Both the challenges need to be addressed quickly & reviewed regularly as these challenges can make the organisation to fail or succeed.

Internal challenges: There are five main internal organizational challenges

a. **Skill & manpower:** Container glass making needs lot of skill along with common sense. There are many unknown variables in process which can impact the glass & bottle quality. If the process owners are not able to closely monitor the parameters & quickly act in case of variations, the impact of this on production may continue for few hours to some days. As furnace is heart of glass manufacturing, what is getting inside it, how it is operating and what is coming out of furnace has direct bearing on container glass quality. Similarly, each forming machine engineers and operators should very well know the skills to form defective free bottles. Many container glass industry suffer because of non-availability of skilled manpower for furnace & IS machine operations. Equally the instrumentation team and IS maintenance team should possess good skills to perform perfect job changes quickly and attend to breakdowns immediately with proper solution.

b. **Machines:** As the glass furnace expected life is around 12 to 14 years now a days, all the machines should operate to the best optimum levels. Proper selection of machines, planning of stand-by equipments, good layout, good maintenance practices will help the machines & equipments to perform to the desired levels continuously and give best performance. As the glass manufacturing equipments are expensive and sensitive to operation, good knowledge of selection of equipments, identification of services (inspection, training, online support, online condition monitoring) and proper installation etc., are very important.

c. **Material:** Glass industry uses many materials like raw materials, refractories, moulds, packing

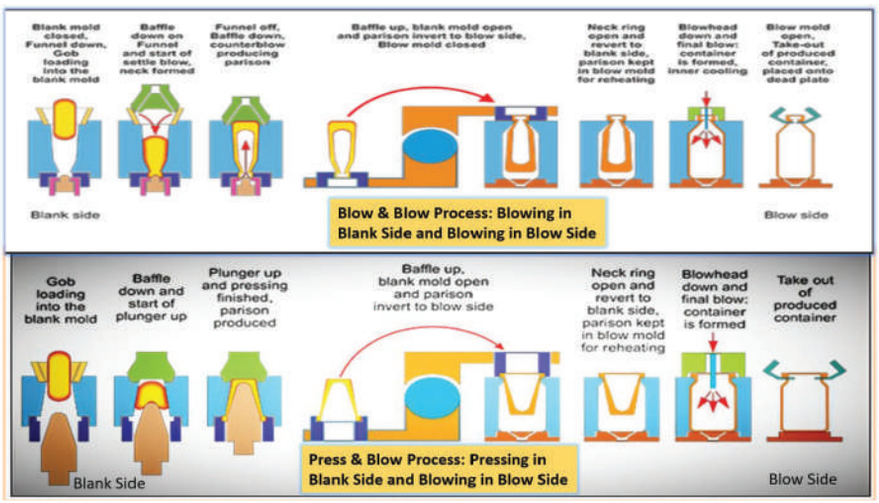


Figure 1.7

material, lubricants, fuels etc. and the availability, cost & quality should be closely monitored. The sum of batch cost, energy cost, packing cost and mould cost will be approximately 70% of the total manufacturing cost, hence good monitoring is very essential. Regular reviews of cost, availability, alternatives and consumption should be performed, to avoid any surprises. Good budget preparation and monitoring system will definitely help to control the challenges.

d. Methods: Due to existence of many process variables in manufacturing, good systems to control each process is essential in glass manufacturing to continuously improve the performance and maintain good profit. Hence good & effective GMP, ISO / IMS, HR, SHE and housekeeping systems should be implemented in high spirit. Management should ensure that these systems are implemented properly and reviewed regularly.

e. Environment: For container glass production, glass has to be melted at very high temperature (approximately 1570°C) and hot glass required to blow the bottle, hence the working environment is hot. As lot of compressed air is required for container glass blowing in IS machines, there exists lot of noise. Also, batching involves fine minerals, hence dust too is an issue. All these factors make the operating environment very challenging. Every action is required to make sure that there are sufficient dust, heat and noise prevention systems installed, so that operating team can work efficiently. In many companies, these challenges remain for very long resulting in high manpower attrition & accidents.

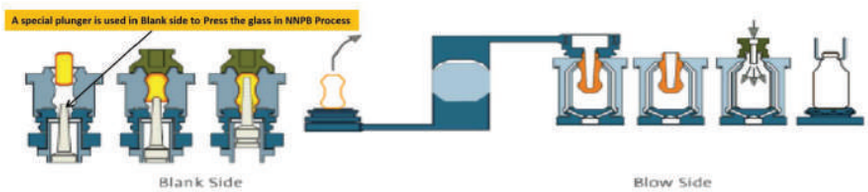
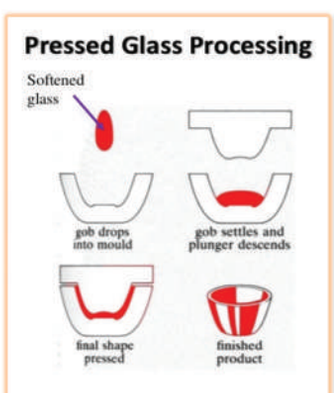


Figure 1.8



In Pressing operation, required quantity (Weight) of glass is poured into Mould and then it is pressed to form the article as shown in this image. Gob forming & Pressing process can be manual or fully automatic. Mostly Mass Manufacturing of Tumblers, Cups and Drinking Glasses are manufactured using Automatic Press Machines and other items like Dish Plates, Jugs etc. are made by Manual Operation.

Figure 1.9

1.10.1 External challenges:

Container glass industry growth is continuously changing globally and also within countries and sectors, mainly due to various factors mentioned below. It is very important to understand these challenges and implement actions quickly so that positive growth is maintained:

1. Government policies and regulations
2. Competition from alternative materials
3. Energy cost
4. Manpower cost
5. Investment cost and economical plant capacity
6. Competition from manufacturers within the country and outside
7. Innovations
8. Sustainability

How to use this book

This book consists of various chapters explaining the container glass manufacturing processes including important trouble shooting charts. This will be a good reference book for everyone involved in glass manufacturing. Additionally, there are chapters on energy conservation, manufacturing excellence and safety. These are currently gaining importance and are very useful for improving the overall performance ■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15th AIGMF International Conference on 'AI and Digitalisation – the future for sustainable glassmaking'

(Sept 11, 2025)

The 15th AIGMF International conference focused on the increased use of Artificial Intelligence (AI) and digital technology in glass manufacturing that was held parallel to the 3-day glasspex/glasspro INDIA exhibitions on Sept 11 at Bombay Exhibition Centre at MUMBAI.

Opening the conference, AIGMF President and AGI Greenpac CEO Mr. Rajesh Khosla delivered a keynote presentation about AI and how it can be applied to the different processes in glassmaking.

Focusing on batch house, furnaces, forming, inspection and packaging, he highlighted how AI and digital technology can deliver benefits to current processes.

By all means, the first ever AI conference on glass making hosted by the AIGMF in association with Messe Düsseldorf and Glass Futures was a huge success.

The technical papers were presented by:

- IIT's (Delhi) Prof. N M Anoop Krishnan *(Dept. of Civil Engineering and Yardi School of AI-joint appointment)* on Revolutionizing Glass Development through AI and large Language Models: from laboratory to industry
- Glass Service's (CZ) Dr. Malte

Sander *(Consultant and Sales)* on Cruise Control for Glass Furnaces: automated furnace control and batch monitoring systems

- Heye International's Ms. Anastasiia Bratash *(Sales Manager-Hot End)* on Driving Efficiency in the Smart Plant

- Iris Inspection machine's Mr. Michael Toelle *(Director Sales)* on Advanced Digitalization in Inspection for Predictive Defect Detection
- Siemen's Mr. Magdi El-Awdan *(Senior Manager Glass & Solar)* on Reducing Glassmaking Emissions: a gateway to the digital future of process control technology

- Gridbots Technologies Pvt. Ltd's Mr. Hiren Rathod *(AGM)* on AI for Mirror and Container Glass (with live display of Robots)
- Celsian's Dr. Oscar Verheijen *(Commercial Director)* on AI-Driven Optimization of Glass Production: overcoming industry challenges with Celfos

The participants touched 135+ from all segments of glass, which was made possible with the support of sponsors namely- AGI, Cello, Dukhiram Maurya, HNG, La Opala, Mascot, NES and Yera.

The high interest in the subjects were evident with professionals from industry associations i.e.

GSI, AIGMF, FOSG; Universities i.e. DTU, VSU Nellore; research bodies i.e. Glass Futures, CGCRI, IIT; Glass International, Glass Global; manufacturers and suppliers coming together to debate on technology enhancement for hi-tech glass manufacturing and processing.

After the Discussions and Q&A, the

program was wrapped-up by Mr. Purvish Shah Hon. General Secretary AIGMF and Director in Gopal Glass Works Ltd., and Gobind Glass and Industries Ltd.

Mr. Lars Wismer Director of glasstec and A+A at Messe Düsseldorf gave the presentation on glasstec 2026 by

inviting glass professionals to the glass event at Düsseldorf GERMANY.

After the vote of thanks by Mr. Pawan Shukla Hon. Treasurer AIGMF; and President and Managing Director, Schott Glass India Pvt. Ltd., the program concluded with a networking lunch.

The theme for the 16th AIGMF International conference will centre around 'Developing an unbreakable Glass and solutions' to be held parallel to glasspex and glasspro exhibitions in 2027. We are looking for a yet another record participation and would welcome papers on the subject covering flat, hollow, solar, vials, decorative and tableware ■

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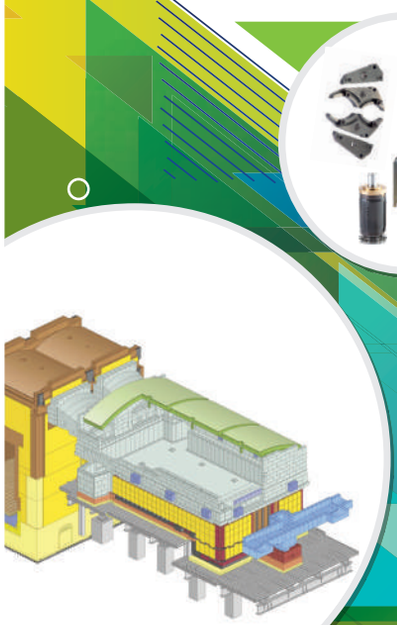

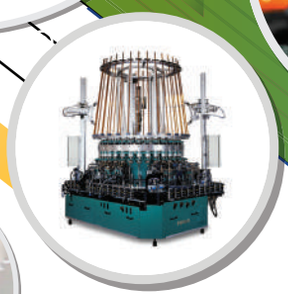

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glasspex INDIA & glasspro INDIA 2025

wrap up in Mumbai with exceptional response from the glass industry

(September 10-12)

8,209 attendees from diverse sectors explored a wide range of products and solutions across the three-day event

The recently concluded 8th edition of glasspex INDIA and 5th edition of glasspro INDIA, held at the Bombay Exhibition Center, MUMBAI from September 10–12 witnessed an enthusiastic response from the glass industry. Over three days of cutting-edge product showcases, insightful conferences and extensive networking, the shows reaffirmed their reputation as key meeting points for the global glass fraternity.

Spanning across 9,230 sqm of exhibition space, the shows hosted 180 exhibitors from India and 18 other countries who presented innovations and technologies that drew significant interest from buyers. Participants described glasspex INDIA & glasspro INDIA as crucial industry platforms, not only for solution providers but also for buyers across multiple sectors.

Organised by Messe Düsseldorf India in association with AIGMF, glasspex INDIA 2025 highlighted glass production, processing and finishing technologies for hollow glass, glass packaging and applications from across the manufacturing value chain.

glasspro INDIA 2025, showcased high-tech flat glass production and processing solutions, advanced tools, auxiliary products, and applications.

A special segment of the event, fenestrationpro INDIA featured discussions on design trends

and energy-efficient building technologies.

The event was inaugurated in the presence of eminent dignitaries, including Mr. Rajesh Khosla, President - The All India Glass Manufacturers' Federation (AIGMF); Mr. Sanjay Somany, Chairman & Managing Director - Hindusthan National Glass and Industries Ltd.; Mr. Yaqoob Khan, CEO - Thermo Tech Furnace & Engineers Pvt. Ltd.; Mr. Rajnath Maurya, Director - Dukhiram Maurya Engg. & Refractory Works (I) Pvt. Ltd.; Mr. Mohammad Mahdi Ghadiri, Director – Sales & Marketing - Kaveh Float Glass Company; Ms. Gesine

Bergmann, Head of Forum Glass Technology - VDMA and Mr. Lakhan Singh, Editor & Publisher - Glass Bulletin.

The shows took place at a time when the glass industry is experiencing robust growth, driven by the rising need for energy conservation, demand for sustainable packaging and the increasing application of glass in construction, design, and architecture. Powered by glasstec Düsseldorf, the world's leading exhibition for the glass industry, glasspex INDIA & glasspro INDIA are the largest of their kind for the Indian glass industry.

EXHIBITOR VOICES

Prominent exhibitors that showcased the best of their innovations include industry leaders such as Thermo Tech Furnace and Engineers Private Limited, Furnotherm Glass Projects India Private Limited, Dukhiram Maurya Engineering & Refractory

Works (India) Private Limited, Shamvik Glasstech Private Limited, Gopal Glass Works Limited, Taiton Hardware Private Limited, Float Glass Centre and Calderys India Refractories Limited.

Mr. Rajesh Khosla, President - AIGMF and CEO/President - AGI Greenpac said, *"The glasspex/glasspro exhibitions from Sept 10-12 at Bombay Exhibition Centre saw the 1st ever AI conference on glass making hosted by the AIGMF in association with Messe Düsseldorf and Glass Futures.*

The participation touched 135 from all segments of glass. The high interest was evident with industry associations i.e. GSI, AIGMF, FOSG; Universities i.e. DTU, VSU Nellore; research bodies i.e. Glass Futures, CGCRI, IIT; Glass International, Glass Global; manufacturers and suppliers coming together to debate on hi-tech glass manufacturing and processing.

I invite all stakeholders to join for the 16th AIGMF International conference

on Developing an unbreakable Glass and solutions to be held parallel to glasspex and glasspro exhibitions in 2027."

Mr. Rajnath Maurya, Director - Dukhiram Maurya Engg. & Refractory Works (I) Pvt. Ltd. said, *"At glasspex INDIA 2025, Dukhiram reaffirmed its leadership position in the industry by presenting cutting-edge Green Field & Cold Repair solutions and proven Hot Repair expertise.*

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We thank Messe Düsseldorf India for providing a platform for deeper connections with customers that strengthens our role in shaping the future of the glass industry."

Mr. Yaqoob Khan, Founder - Thermotech Furnace & Engineers Pvt. Ltd. exclaimed, *"We are delighted to share that our participation in glasspex India 2025 was a great success.*

The event provided us with an

the next edition and extend our sincere thanks to the Glasspex India team for organizing such a valuable event."

Mr. Hemant Kathuria, Director - Taiton Hardware said, *"Taiton had the privilege of exhibiting at the glasspro exhibition in Mumbai, and we are pleased to share that the experience was highly rewarding.*

The event was exceptionally well organised and offered an ideal platform to showcase our product range to a focused and relevant audience.

We received excellent response and engagement from visitors, which has excellent platform to connect with new customers, strengthen existing relationships, and explore collaborations. A highlight for us was finalizing an order on the very first day, reflecting the quality and potential of this exhibition.

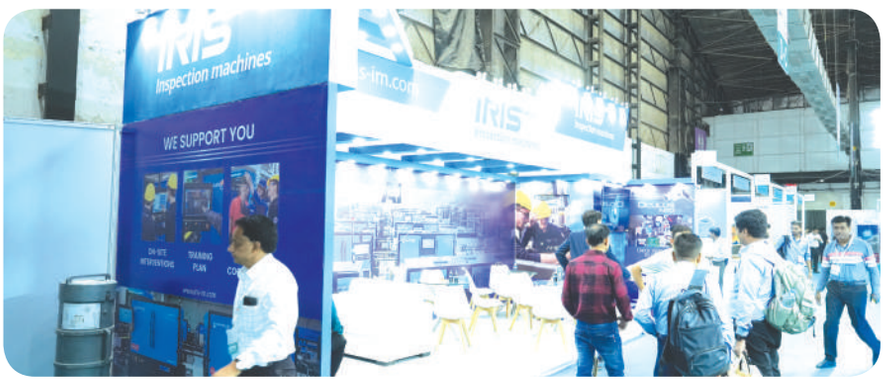
The vibrant atmosphere, strong engagement, and promising opportunities reaffirmed our confidence in the growth of the glass industry, both in India and globally. We look forward to

opened up new opportunities for us within the industry. We sincerely appreciate the efforts of the organisers in creating such a professional environment and look forward to participating in future editions."

The 2025 edition attracted participation from 19 countries, including Belgium, Brazil, Bulgaria, China, Czech Republic, France, Germany, Hong Kong, Indonesia, Italy, India, Iran, Japan, Mexico, Poland, Thailand, Turkey, United Kingdom and United States of America. Germany and Italy also hosted dedicated country pavilions.

Ms. Millie Contractor, General Manager – Messe Düsseldorf India, commented, *"The 2025 editions of the shows have truly set a new benchmark for the glass industry, both in terms of participation and business interactions.*

With strong representation from India and overseas, the event served as a dynamic platform for networking,



knowledge exchange and discovering innovative solutions. The success of glasspex INDIA & glasspro INDIA 2025 clearly reflects the industry's immense growth potential."

Day 1 concluded with the 6th Glass Bulletin Awards, celebrating outstanding achievements of individuals and companies contributing to the glass industry's growth.

The glittering ceremony brought the industry together for an evening of recognition and celebration.

In parallel, the 15th International Conference, organised by The All India Glass Manufacturers' Federation (AIGMF) on September 11 brought together over 135 delegates for in-depth deliberations on the theme *'AI and Digitalisation – The Future for Sustainable Glassmaking.'*

The shows concluded on a high note with strong optimism for the future of the industry.

The 9th edition of glasspex INDIA and 6th edition of glasspro INDIA will return to the Bombay Exhibition Center from September 23–25, 2027■

For more information on the shows, visit: www.glasspex.com
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Mr. M.D. Farooq, the founder of Umda Enginering, brings to the table more than 35 years of expertise in the manufacturing industry. Starting from humble beginnings, today more than 350 of Mr. Farooq's Lehr machines are successfully installed around the world.

Mr. Farooq is best recognised as one of the co-founders of TNF Engineering, a company known across the industry as not only the leading manufacturers of Metallic Wire Conveyor and Lehr belts but also of Glass Plant Equipment. This mantle of superior performance and expertise has now been passed on to Umda Enginering.

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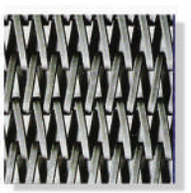

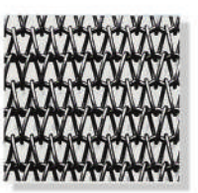

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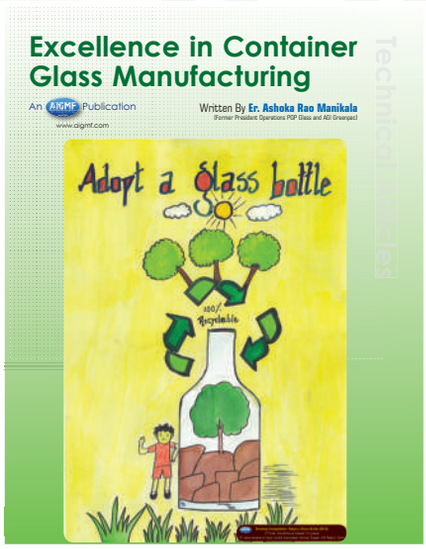
Release of book on Excellence in Container Glass Manufacturing

(Sept 11, 2025)



Published by the AIGMF and authored by Er. Ashoka Rao Manikala, *Former President Operations, PGP Glass and AGI Greenpac, a* comprehensive book written with the sole intention of sharing knowledge and enhancing the understanding of those working in the glass industry was released on Sept 11 by the Office Bearers and Ex Com Members at the 15th International conference of AIGMF on AI in glass manufacturing at MUMBAI.

The chapters have been prepared to enhance the understanding of those working in the glass industry.

This invaluable resource covers essential aspects of container glass manufacturing.

The book will help everyone working

in the container glass industry, the suppliers & service providers, container glass customers and students pursuing studies on glass manufacturing.

The book is available for Rs. 1000 within India and USD 75 for overseas including postage and GST with

bank details given at https://aigmf.com/excellence-container-glass

From the Oct-Dec 2025 issue, a chapter each would be covered over a series of articles from the Book in KANCH ■

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World Soda Ash Conference

(Oct 7-9, 2025)

The World Soda Ash Conference 2025 was held from October 7-9 at Palma Convention Centre, Palma de Mallorca, SPAIN focusing on market trends, sustainability, and networking opportunities.

The conference was hosted by Chemical Market Analytics by OPIS, a Dow Jones Company and was supported by the AIGMF.

The conference featured a variety of sessions and workshops, including: Workshop Day (October 7): focussed on "The Commercial Impact of Soda Ash" and discussions on global trade, logistics, and the role of government in the soda ash industry.

Conference Day 1 (October 8): sessions on global industry outlooks, market dynamics, and regional market outlooks.

Conference Day 2 (October 9): focussed on sustainability, innovation, and market drivers affecting the soda ash industry.

Participants got the opportunity to connect with industry leaders, producers, and buyers, providing a platform for valuable networking and collaboration.

Like previous shows, AIGMF supported the event as a media partner.

Mr. Aashish Tyagi, Member AIGMF and Director with Gold Plus Glass Industry Limited gave the presentation on Indian Market Scenarios: Flat, Solar Glass and Soda Ash Requirement.

Some of the AIGMF members participated directly ■

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Launch of Calendar Glass Bottle 2026

(Sept 11, 2025)

At the 15th AIGMF International conference on AI and Digitalisation on Sept 11, AIGMF President Mr. Rajesh Khosla launched the Calendar Glass Bottle 2026. The bottle has specially been designed by AGI glaspac from recycled glass.

The calendar bottles were gifted to all speakers and important guests at the conference.

As part of the glass promotion, the calendar glass bottle will be sent to key stakeholders i.e., Members of Parliament; GoI Secretaries; office of Chief Secretaries; LGs/Administrators; Chief Ministers; select GoI contacts; Trade Chambers; Education Secretaries; FOSG; AIGMF Members; Regional Associations; Select Universities and Schools; Firozabad; CSIR-CGCRI; BHU; CDGI; General; Overseas Glass Associations and other contacts etc.

These promotional bottles will also be used during industry events in 2026 ■

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Chalcogenide Glasses: A vision beyond visible (Part-3)

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& Dr. Pritha Patra
(CSIR-Senior Research Fellow)
CSIR-Central Glass & Ceramic Research Institute (CGCRI), Kolkata
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In the previous editions, we explored novel characteristics of chalcogenide glasses, their diverse applications, and rising demand in the current global market scenario. However, considering the stringent requirements of chalcogenide glass preparation, which involve maintaining an oxygen-free environment throughout the processes (like chemical batch preparation to glass melting using distillation), only a few global manufacturers, such as 'Umicore (USA)', 'Schott Inc. (Germany)', 'Hubei New Huaguang (NHG) Material Technology Co., Ltd. (China)', and 'Luoyang Dingming Optical Technology Co., Ltd. (China)' are involved in large-scale commercial production of chalcogenide glasses. Being a non-oxide glass, oxygen, hydrogen, or moisture behaves as the impurity in the case of chalcogenide glass. These impurities can come from precursor chemicals, silica ampoules, or from impurity micro-inclusions that formed by the reaction between chemical impurities and raw material at high temperature. The presence of even a few ppm of impurities (oxide/hydride/hydroxide/moisture/carbide) can deteriorate the transmission properties of these glasses, due to their characteristic absorption peaks in the near to mid-infrared region. The impurities may also cause changes in the density and refractive index of the glasses, followed by reducing their thermo-mechanical stability and optical homogeneity. The reduced optical homogeneity results in optical losses during interaction with IR-radiation, thereby deteriorating thermal image quality. Further, the refractive index homogeneity with the precision of 1.5×10^{-6} is desirable for lens fabrication. Any impurity

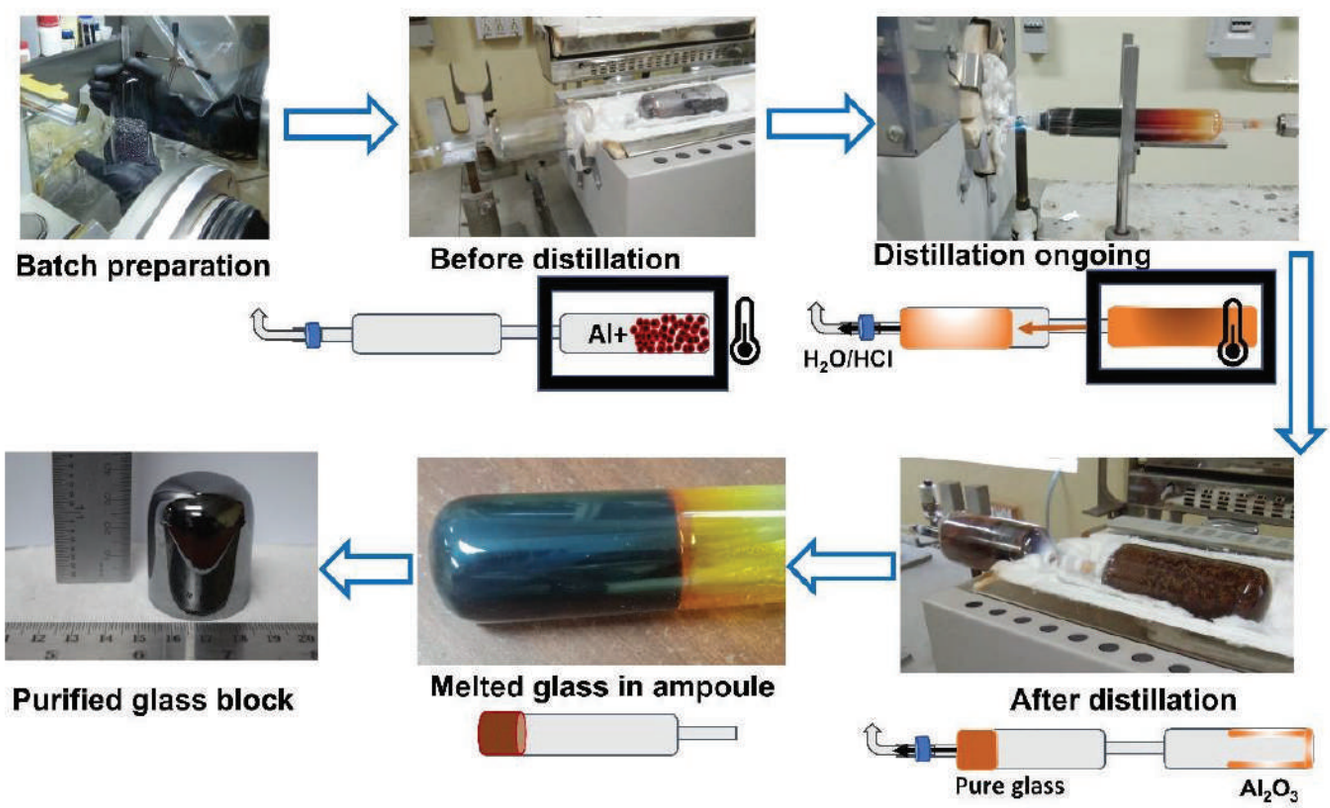


Figure 1. *Step-by-step distillation procedure in a pictorial collage, along with the probable schematic of the process occurring.*

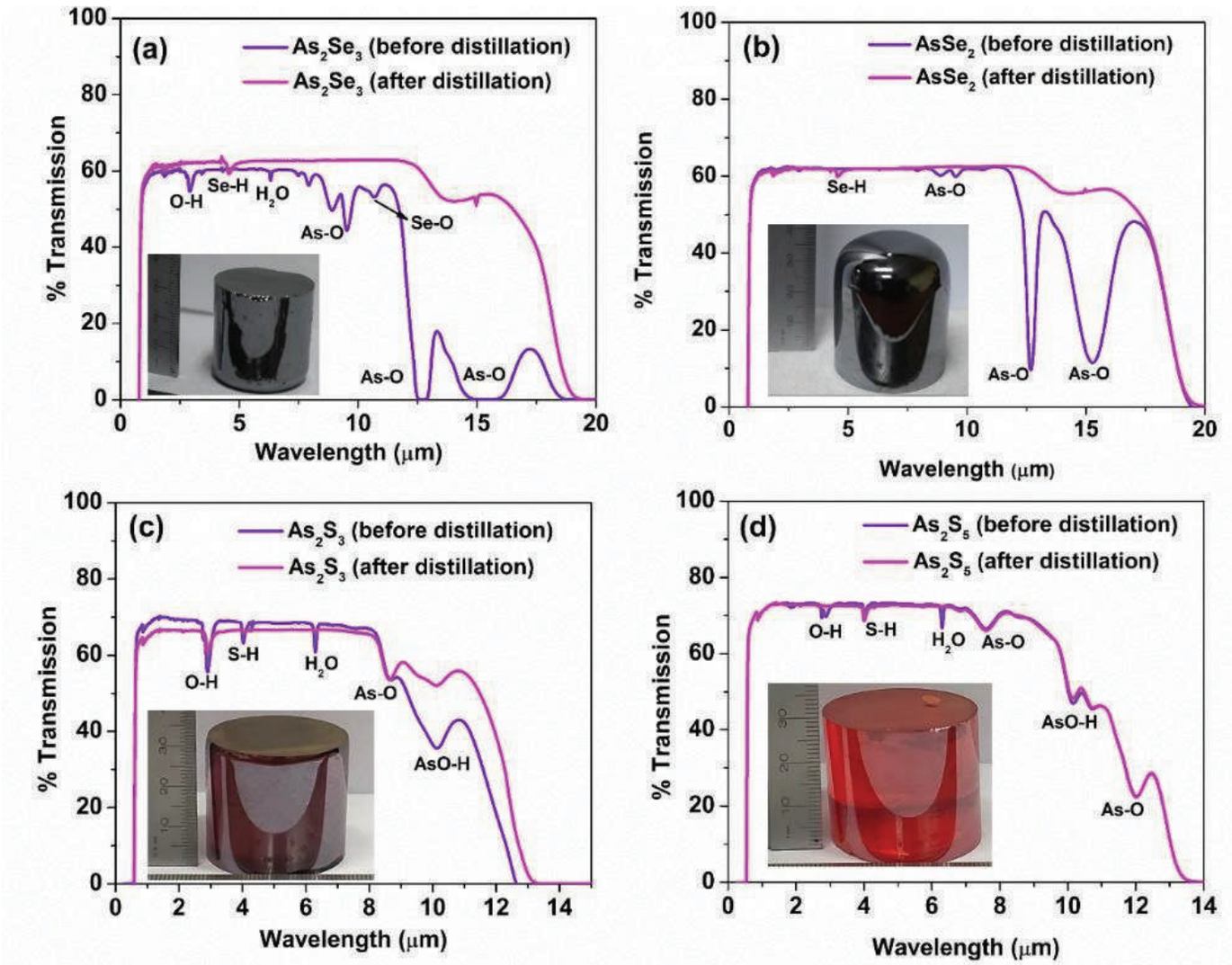


Figure 2. *Transmission spectra of 30 mm thickness a) As_2Se_3, b) $AsSe_2$, c) As_2S_3 and d) As_2S_5 glass before and after distillation (inset: photographs of the respective glasses).*[1]

content should be below 10 ppb to obtain a good-quality image. It has been observed that the use of ultra-high-purity precursor chemicals alone cannot help in attaining impurity-free glasses. Hence, a specially designed glass melting setup is needed for chalcogenide glass preparation. However, due to the high vapour pressure of chalcogen elements, it is difficult to prepare impurity-free chalcogenide glasses on a large scale. Over the years, globally, several research groups have been dedicatedly working on optimizing a proper distillation (chemical purification) process using scavenging agents like Al, Mg, $AlCl_3$, $TeCl_4$, and $GaCl_3$ to remove or minimize the presence of oxide, hydride, carbon, and hydrocarbon-based impurities.

However, no Indian glass industries are involved in producing bulk chalcogenide glasses. In this scenario, CSIR-Central Glass and Ceramic Research Institute (CGCRI), Kolkata, India a premier national research institute engaged in research on various kinds of glass and ceramic materials, has established a state-of-the-art facility for manufacturing and non-oxide chalcogenide glasses. Initially, as a part of CSIR's 12th five-year plan program, a laboratory-scale (up to 50-100 g) chalcogenide glass preparation setup was established.

Later, the facility was scaled up to moderate production capacity (a few Kg) with the establishment of a glass distillation unit. As a part of a CSIR-funded project work, CGCRI has successfully developed different high-purity As-S and As-Se based chalcogenide glasses suitable for extended mid-infrared photonic applications (broadband super continuum generation).

A simple double-container vacuum distillation method is performed to remove impurities from the glass using 150-300 ppm high-purity (5N) metallic aluminium as a scavenging agent. After completion of the distillation process, purified glass

vapour is transferred to another tube and finally melted in a rocking furnace at a suitable elevated temperature for sufficient time to attain a homogenized molten glass, followed by quenching in the standard procedure (air and water quenching for S glasses and Se/Te glasses, respectively).

A photographic collage of the distillation, glass preparation process, and final glass product is given in Figure 1 along with the schematic mechanism.

Figure 2 shows the photographs of each glass cylinder (30 mm $\phi \times 30$ mm thickness), along with the improvement in their transmission spectra after distillation. Later, Germanium-Arsenic-Selenium (Ge-As-Se) glass was developed.

Further, interest has been generated towards preparing arsenic-free, comparatively non-toxic Germanium-Antimony-Selenium (Ge-Sb-Se) based chalcogenide glasses for thermal imaging applications.

The photographs of selenium-based chalcogenide glasses of various sizes and shapes prepared in the Specialty Glass Division, CSIR-CGCRI, under the thermal imaging glass fabrication project, along with the photograph of the respective research and development group (Figure 3).

Additionally, the research team of CSIR-CGCRI is also simultaneously carrying out fundamental research for developing new, and unique chalcogenide glass compositions, through complete structure-property analysis of each glass.

To mention a few of such glass compositions: $As_{(8-14)}S_{(48-60)}Sb_{(12-24)}I_{(10-20)}$, $As_{14}Sb_{26}S_{(60-x)}$-xAgI (x= 2-10), $As_{(40-45)}Se_{10}Te_{(40-45)}$), etc, which exhibit infrared transmission windows ranging from 12.5 to 25 μm.[2–4]

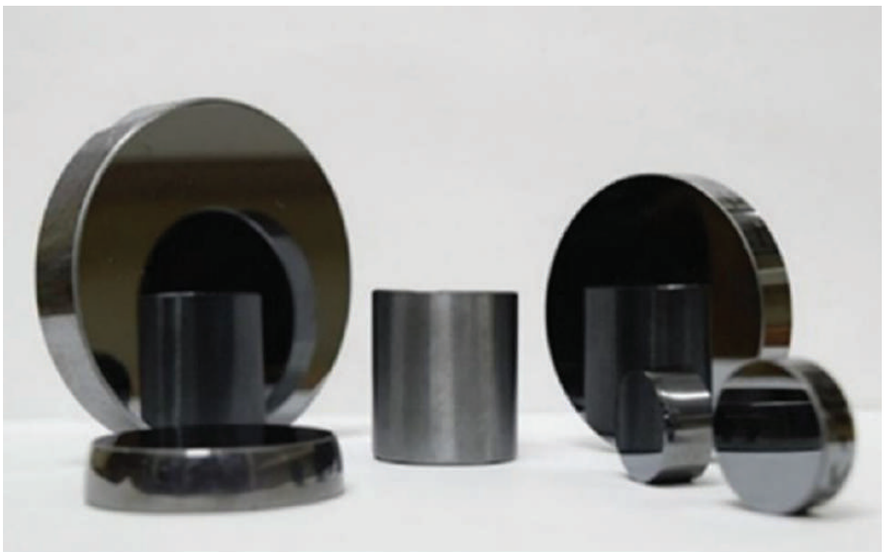
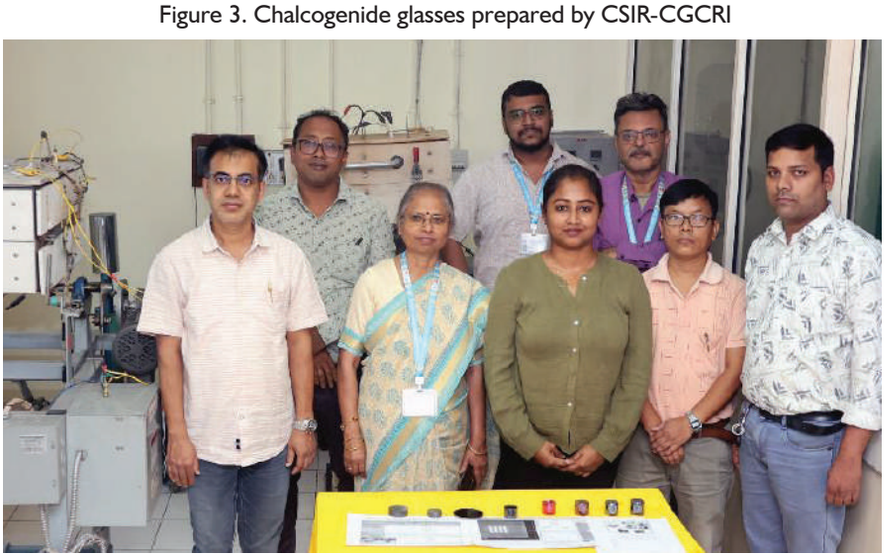


Figure 3. Chalcogenide glasses prepared by CSIR-CGCRI



Team CSIR-CGCRI

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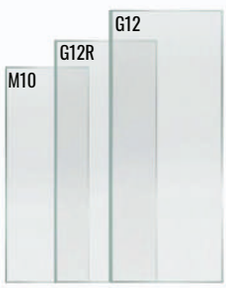

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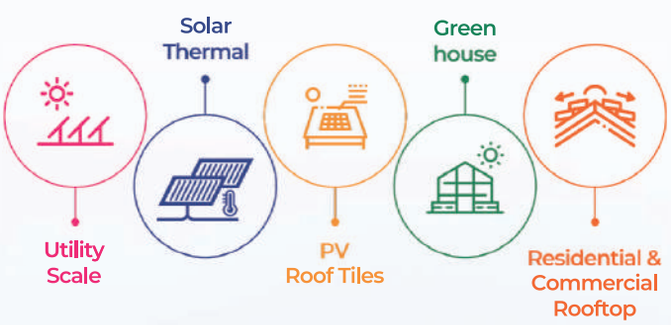

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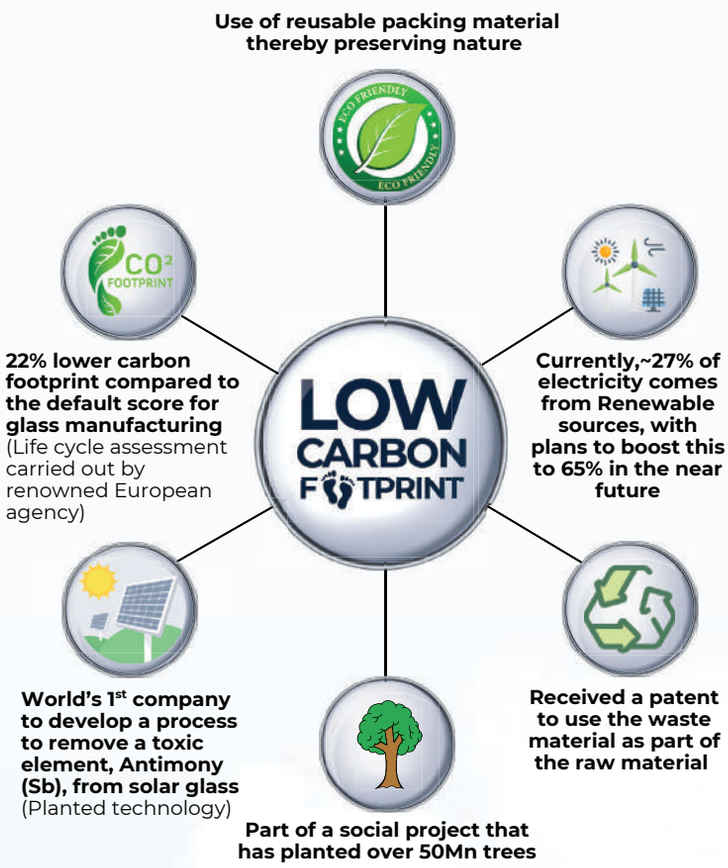

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Foreign Companies supplying machinery etc., to the glass industry are also enrolled as **Affiliate Members**.

Membership forms can be downloaded from www.aigmf.com/membership.php

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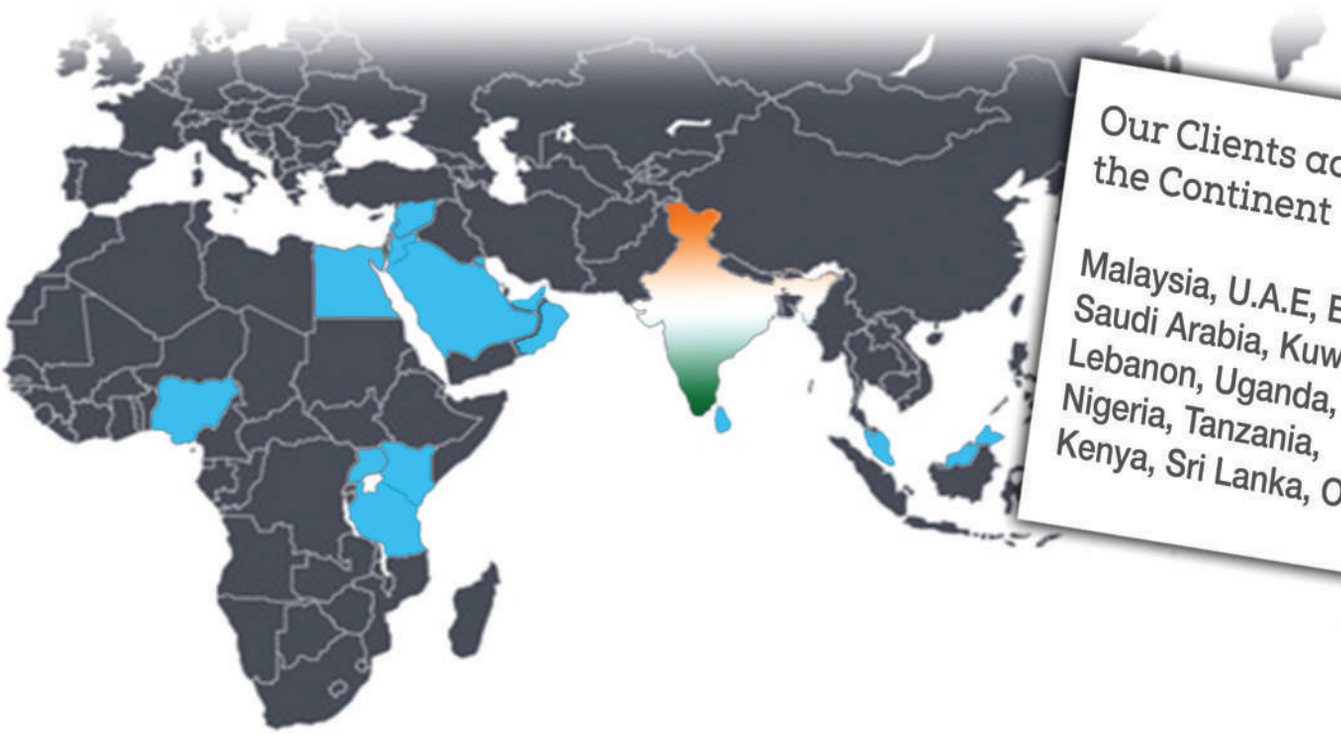

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