

GLASS – A Sustainable Building and Packaging material

An **AIGMF** Publication

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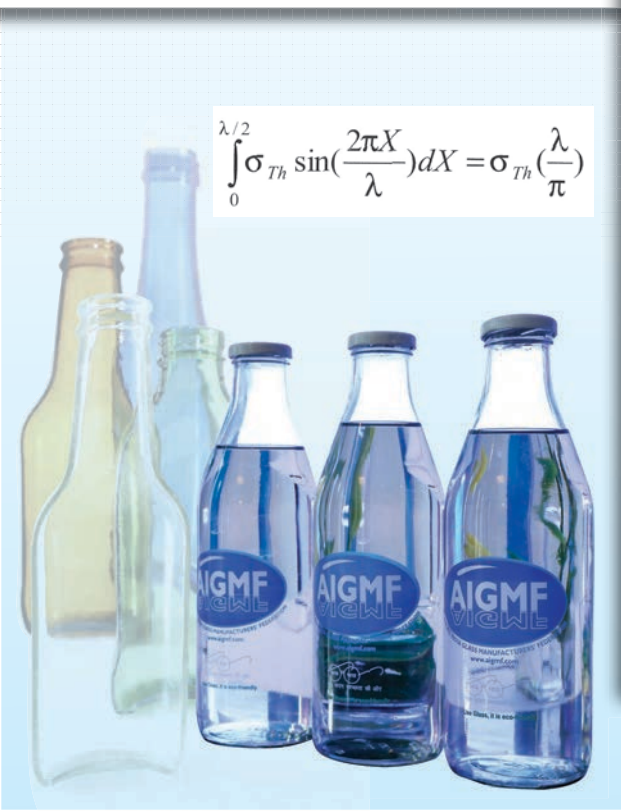
Prof. (Dr.) A. K. Bandyopadhyay

Technical Articles



$$\frac{dn}{dk} = -\frac{gp}{2\eta} k^{-2} + \frac{\gamma}{2\eta} = 0$$

$$\sigma_{Th} = \sqrt{\frac{\frac{E\gamma}{a}}{\left(\frac{\pi\delta}{\lambda} + \frac{2\pi^2\delta^2}{\lambda^2}\right)}}$$



$$\int_0^{\lambda/2} \sigma_{Th} \sin\left(\frac{2\pi X}{\lambda}\right) dX = \sigma_{Th} \left(\frac{\lambda}{\pi}\right)$$





About The All India Glass Manufacturers' Federation

The All India Glass Manufacturers' Federation was founded in 1944. The Federation is made up of five Regional Associations viz.

- Eastern India Glass Manufacturers' Association (EIGMA)-Kolkata
- Northern India Glass Manufacturers' Association (NIGMA)-Haryana
- South India Glass Manufacturers' Association (SIGMA)-Hyderabad
- Uttar Pradesh Glass Manufacturers' Syndicate (UPGMS)-Firozabad and
- Western India Glass Manufacturers' Association (WIGMA)-Mumbai

The Federation was incorporated under the Companies Act, 1956 (No. 1 of 1956) as a Limited Company on 15-6-1970. The main aims & objectives of the Federation are:-

- To encourage, promote and develop the manufacture of glass articles of all kinds and to safeguard and protect the interests of glass industry and glassware business in India.
- To form a common link amongst Glass Manufacturers' in India and thus develop a spirit of mutual help and co-operation with one another.
- To promote the study and research in Glass Technology.
- To consider all matters relating to the manufacture and marketing of glass articles in India and the question of export and import thereof.
- To devise ways and means for securing necessary supply of raw materials required for the manufacture of glass articles at comparatively lower prices and thus to decrease the cost of production and increase the national wealth.
- To collect necessary information and data and propagate it for the benefit of Glass Industry and trade in India.
- To make representations whenever necessary to the Union Government or any unit of the Union of India for the removal of difficulties that might hamper the trade of glass articles or for grant of special facilities for the Glass Industry.
- To draw Government or public attention to the difficulties in the way of Glass Industry and to solve other problems confronting it and to solicit their help and support through concerted action.
- To organise a united front on behalf of all glass manufacturers and thus strive to gain all those advantages which may not be possible through individual effort.

All those engaged in the manufacture of glass and glass articles are enrolled as **Ordinary Members** of the AIGMF and those associated with the Glass Industry are enrolled as **Affiliate Members** of the Federation.

Almost all glass manufacturers including many in the small scale sector are 'Ordinary' members of the Federation.

Articles of Association of the AIGMF were amended in September 1992 to enroll foreign companies as Affiliate Members of the Federation ■

GLASS – A Sustainable **Building and Packaging Material**

Compilation of Technical Articles published in KANCH (*Quarterly Journal of The All India Glass Manufacturers' Federation*)

By

Prof. (Dr.) A. K. Bandyopadhyay

MEMBER EDITORIAL BOARD,

KANCH (QUARTERLY JOURNAL OF THE AIGMF)

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GOVT. COLLEGE OF ENGG. & CERAMIC TECHNOLOGY

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Reference of KANCH has appeared in all articles.

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Front Cover Photographs (*from top to bottom*):

- a) 302 KVA rooftop installation on top of 80000 sq. ft. warehouse of Borosil Group Company © Borosil
- b) Lotus shaped glass facade building of Motisons Jewellers at Jaipur- © AIGMF
- c) Glass Bottles specially manufactured by HNG & Inds Ltd., in tune with Swachh Bharat Abhiyan- Clean India Campaign © AIGMF

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Foreword

Ever since announcement made by the Government of India on Swachh Bharat Abhiyan (Clean India Campaign) and Smart Cities, Glass Industry has made sincere efforts to showcase glass as an excellent building material for smart and solar cities. Similarly, Glass being a sustainable packaging material supplements Swachh Bharat Abhiyan.



The All India Glass Manufacturers' Federation (AIGMF) organized special programmes in Delhi / Jaipur / Mumbai and other parts of India, where emphasis was given on use of more glass application as it directly aides both these pilot projects of Govt. of India. On September 12, 2015, an Interactive Session on Green Buildings was organised at Paharpur Business Centre, LEED Platinum/BEE 5 star Building in New Delhi with an idea to introduce Green Buildings concept to its members and to debate on use of glass in buildings as eco-friendly measure. As Corporate Social Responsibility, 100 glass water bottles were gifted to Paharpur Business Centre to further strengthen green building concept.

On December 19, 2015, an interactive session with Honb'le Minister of Industry for Rajasthan, Mr. Gajendra Singh was organized at Jaipur, which provided an opportunity to debate on use of glass containers as responsible and safe packaging for clean India campaign and use of glass as eco-friendly building material for Smart Cities.

Mr. Singh emphasized use of more solar and flat glass for building Smart Cities. He appreciated Glass Industry's commitment towards 'Swachh Bharat Abhiyaan' & 'Smart Cities' and offered support to the Industry with regard to investments in State of Rajasthan.

Mr. C K Somany, Former AIGMF President / Former CAPEXIL Chairman and Chairman of HNG Group gifted 500 glass water bottles (specially manufactured by Hindustan National Glass and Industries Ltd.) to the Honb'le Minister for use in 'Secretariat' which carried a logo of Swachh Bharat Abhiyaan enabling people demand responsible and safe packaging.

While in Jaipur, AIGMF members visited select glass façade buildings to showcase its commitment for the uninterrupted supply of glass as a vital building material for Smart Cities.

As Corporate Social Responsibility, AIGMF gifted 200 glass water bottles to Jaipur Marriot Hotel and 50 bottles to lotus shaped glass façade building of Motisons Jewellers.

As a Supporting Association, AIGMF participated in IGBC's Green Building Congress 2015 at Gandhinagar, Gujarat from Nov 19-21, 2015 wherein Mr. Sourabh Kankar, Member, Architectural Glass Panel (AGP) / AIGMF and Manager - Architectural, Gujarat Guardian Ltd., gave a presentation on Principles of Glass Selection for Facades at the Indian Green Building Council's (IGBC) Conference.

With regard to solar cities, one of our prominent members, Gujarat Borosil Limited (GBL) is the only manufacturer of High Transmission Low Iron Textured Solar Glass in India. This finds wide application in Solar Photovoltaic modules, Solar thermal heaters and Green houses. The highly rated testing laboratory SPF of Switzerland has rated this glass as having an efficiency of 95.2% thus making it the world's highest performing solar glass for application in photovoltaic panels.

Further, at 80 PPM, this glass has been acknowledged by Fraunhofer Institute, Wurzburg, Germany to have the lowest iron content in the world. When tested by PICON, Berlin, Germany, for Potential Induced Degradation (PID) in solar modules, alongwith glass from four other leading manufacturers of the world including in Europe, their glass has been found to be the highest performing amongst all. In a technological breakthrough, GBL has become the world's first manufacturer to produce solar glass without Antimony, a highly toxic element.

Consultations have been carried with The Ministry of New and Renewable Energy (MNRE), Bureau of Energy Efficiency (BEE), Ministry of Commerce and Ministry of Finance to provide special subsidy to promote solar glass as a sustainable building material for Smart cities in order to achieve Prime Minister's vision for Clean India.

I am pleased to inform that Dr. AK Bandyopadhyay, Member Editorial Board of KANCH (quarterly journal of The All India Glass Manufacturers Federation) has been writing regularly on glass sector including glass usage in smart cities and container glass packaging solutions for Swachh Bharat Abhiyan. For the benefit of readers, AIGMF decided to compile select Articles contributed by Dr. Bandyopadhyay in KANCH (<http://www.aigmf.com/kanch.php>) which is presented in this book.

I would like to thank Dr. AK Bandyopadhyay for his excellent contributions and hope this book would prove to be a useful resource for building solar and smart cities and will also supplement Swachh Bharat Abhiyan as Glass Industry's initiative.



Sanjay Ganjoo
President AIGMF

And COO, Asahi India Glass Ltd., Taloja (Maharashtra)

About the Author

Prof. (Dr.) Asis Kumar Bandyopadhyay is a truly materials scientist with specialization in glass technology with about 38 years of experience in Industry, Academia and Research in diverse fields of materials science and engineering. After obtaining his B.Tech. in Ceramic Technology from Calcutta



University in 1971 with a Gold Medal, he went to the Indian Institute of Technology (Kanpur) in the materials science department for doing his M.Tech. in 1974, and his research project was then sponsored by Pilkington Bros. (UK) on 'semiconducting switching oxide glasses containing bismuth and selenium nano granules'. He then proceeded to UK to do his Ph.D. in glass technology in the most prestigious institute at Sheffield University with a fellowship from SRC (UK) and completed his work in a record time of 2 years and 8 months in January, 1977, on "electrical conduction and spectroscopic behaviour of oxide glasses containing transition metal oxides". The latter work was also useful for colouration in container glasses.

After a brief stint at Sussex University near London as a post-doctoral fellow on 'solid state battery systems on Suzuki crystals' useful for batteries in the automobile sector, Dr. Bandyopadhyay proceeded to work in one of the most famous Glass Laboratories in Europe at Montpellier (France) in January, 1978, under Prof. J. Zarzycki (ex-Director, St. Gobain Research in Paris) on nano materials and glass-ceramics, where he did a lot of collaborative work with industries in Europe including St. Gobain at Aubervilliers. He was on a special UN project in Mexico City for 4 months in 1982.

After returning to India in 1983, he spent about 4 years in teaching and research at College of Ceramic Technology (Kolkata) he worked in several industries such as Grindwell Norton Ltd at Bangalore (now St. Gobain) and KHSL at Kolkata in very senior positions and later worked for Indian Rayon Ltd. (Aditya Birla Group) as Vice-President (Marketing). After 1987, he spent about 2 years as a consultant in Ent. Gagneraud (Paris). After about 12 years in industry, he decided to come back to academia again as a Professor in glass technology in 2000 at Govt. College of Engineering & Ceramic Technology (Kolkata), where he became Principal in 2007 to take care of a large project funded by World Bank. He retired in 2010 after successfully completing the project, apart from teaching and research in collaboration with various US and European Universities.

Thereafter, he devoted his time for research on materials science in collaboration with several Universities in the USA as well as some consultancy work with a strong inclination towards mergers & acquisitions (M & A).

Since 2012, Dr. Bandyopadhyay has been actively associated with AIGMF in the Editorial Board of “KANCH” and other relevant activities. His recent interest is on ‘solar energy for smart cities’, which involve a tremendous level of activities in both Govt. and Private sectors. He is a first class strategist and as a regular writer in KANCH (<http://www.aigmf.com/kanch.php>) on various issues on glass science and technology, he has been making a serious effort in promoting the usage of glass in India thereby helping the ever-growing glass industry.

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IT'S CLEAR THAT GLASS HAS NO PEER.



AIGMF - Catering to the needs of Glass Industry



Glass is **Inert** and
wholly **Recyclable**



Glass bottle is
Environment Friendly
and **Hygienic**



Contents in glass
bottle **Cools Faster**
and is **Refreshing**

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