

Glass coating related industry and development in Southeast Asia area

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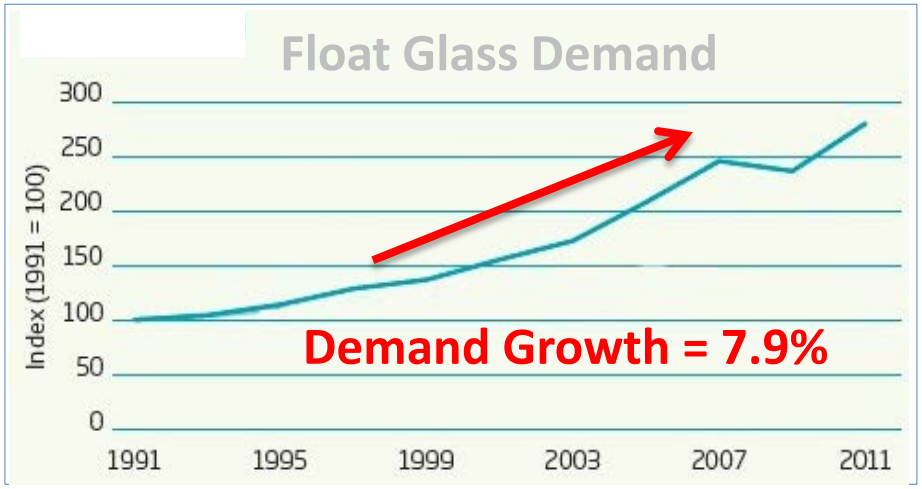
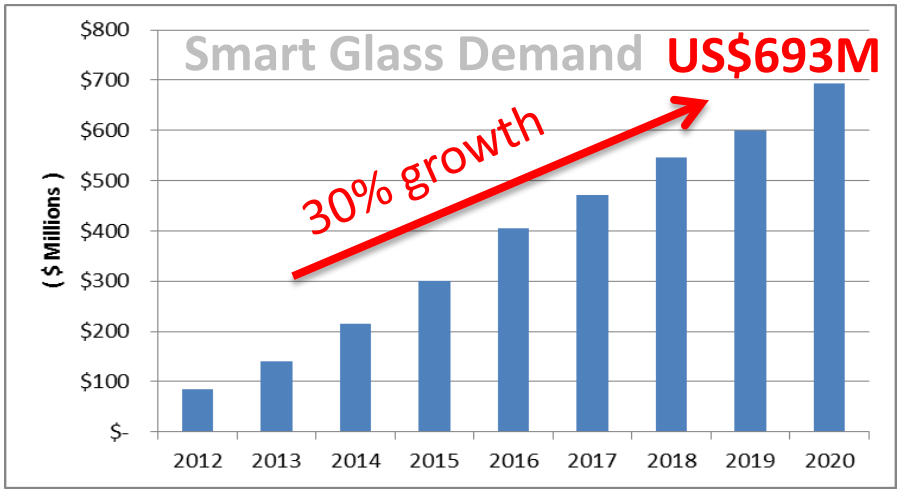
28 June, 2015 Tampere, Finland

Global Glass Coating Industry Overview

- Glass industry is not new but global demands are increasing
- High-value coating and glass products, leading to high-value post-manufacturing processes.
- Great opportunity for innovation due to emerging needs such as energy efficiency, mobile gadgets, smart glass, etc.



http://www.nsg.com/en/about-nsg/whatwedo

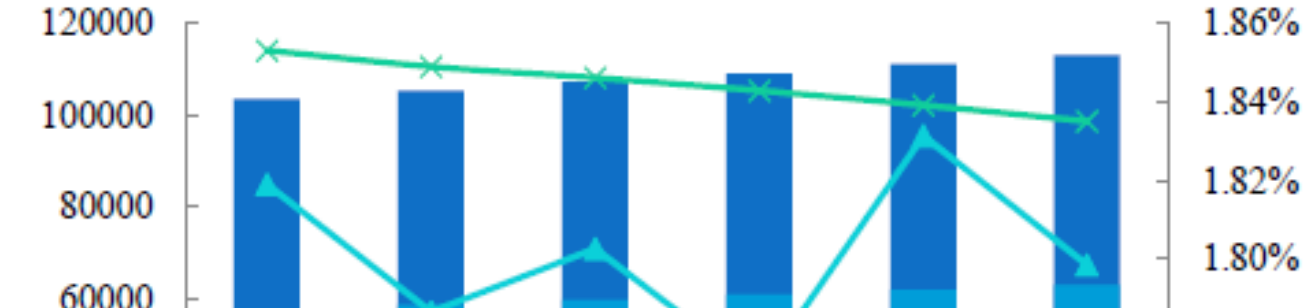


http://www.navigantresearch.com/blog/smart-glass-makers-expand-to-meet-growing-demand

Southeast Asia Glass Coating Industry Overview

- The market for coated flat glass has been growing at a significant rate in pace with the flat glass industry for the past five years.
- The economic downturns have affected many end-user industries of coated flat glass, including construction, automotive and solar glass industries.
- The demand for coated flat glass is driven by the increasing demand for their application in construction, solar and electronic industries coupled with the global economic recovery.
- In addition, legislations and regulations focusing on reduction of CO2 emissions and energy saving are contributing toward growth in the coated flat glass market.
- The upgrading of the existing buildings in these regions offers a huge opportunity for the coated flat glass market, mainly for low-E glass, which has insulating and solar control properties to increase the energy efficiency.
- In the longer-term, the developing countries, including China, Thailand, India and others, will create many opportunities for the coated Southeast Asia Coating Glass Industry.

Southeast Asia Glass Coating Market– Indonesia



	2016 E	2017 F	2018 F	2019 F	2020 F	2021 F
Capacity (K Sqm)	103550	105400	107300	109200	111200	113200
Production (K Sqm)	57487	58550	59631	60730	61847	62982
Capacity Growth	1.82%	1.79%	1.80%	1.77%	1.83%	1.80%
Production Growth	1.85%	1.85%	1.85%	1.84%	1.84%	1.84%

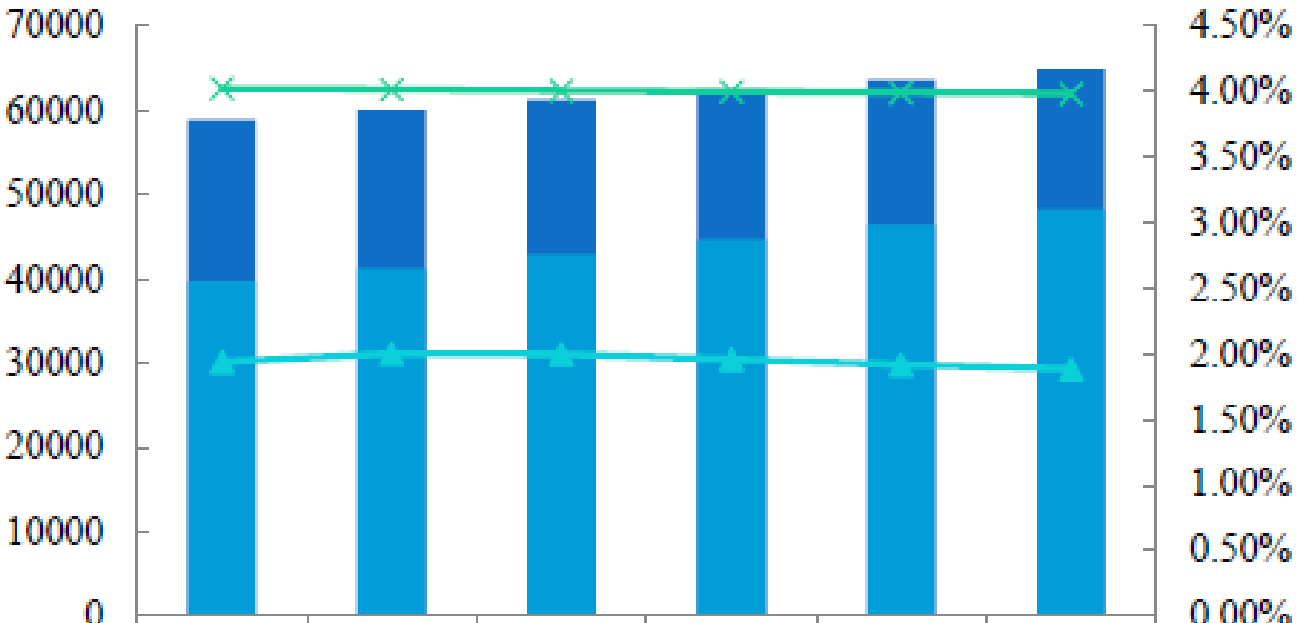
Source: QYR Coating Glass Research Center, Dec 2016

Southeast Asia Coating Glass Market– Indonesia

Manufacturers	Products	Production (k sqm)	Value (m USD)
Asahimas Flat Glass	Flat Glass; Automotive Glass	15807	182
MAGI	Clear Float Glass; Tinted Float Glass; Reflective Glass; Low-E Glass,etc	10972	125
PT. Tamindo Permaiglassl	Safety Glass (Laminated Glass, Tempered Glass) Insulating Glass for Automotives, Buildings, Furnitures	5368	57
Intan Glass Product	Reflective Glass;Pattern Glass;D'Glass (Laminated);Safety Glass,etc.	993	10
PT. BMG	Float Glass;Tempered Glass; Laminated Glass; Glass;Ceramic Fritted Glass	973	10

Source: QYR Coating Glass Research Center, Dec 2016

Southeast Asia Glass Coating Market– Thailand



	2016 E	2017 F	2018 F	2019 F	2020 F	2021 F
Capacity (K Sqm)	58920	60100	61300	62500	63700	64900
Production (K Sqm)	39679	41274	42929	44647	46431	48282
Capacity Growth	1.94%	2.00%	2.00%	1.96%	1.92%	1.88%
Production Growth	4.03%	4.02%	4.01%	4.00%	4.00%	3.99%

Source: QYR Coating Glass Research Center, Dec 2016

Southeast Asia Glass Coating Market- Thailand

Manufacturers	Products	Production (k sqm)	Value (m USD)
Guardian	Automotive, Building materials distribution, Glass	10452	206
AGC Flat Glass Thailand	construction, automotive, industrial various float glasses, figured glass, mirror, and architectural fabricated glass	8017	169
Thai-German Specialty Glass Co., Ltd	Standard Product Glass; Energy saving Glass; Decorative Glass; Secrity Glass;Specialty Glass; etc.	4724	44
Glassform Co., Ltd	Mirror, Decorative, etc	2853	27
Wattanachai Safety Glass	Tempered Glass; Laminated Glass; Mirror Glass; Reflective Glass; Float Glas;, etc.	2197	20
PMK	safety glass. energy-saving glass, interior decoration galss and glass for other industrial	9258	89
V.M.C.	Canopy; Bullet-proof glass; Automotive glass;etc	1163	10

Southeast Asia Glass Coating Market - news

1. AGC to Set Up Solar Control Coating Facility in Indonesia for its Architectural Glass Production (Nov. 9, 2016)

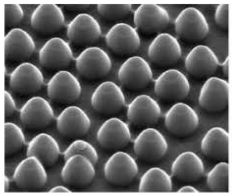
2. Gomelsteklo put into operation a line for the production of coated glass (Nov. 15, 2016)

3. China’s largest glass manufacturer Kibing raise its investment in Malaysia by 100% to US$400mil (RM1.6bil) and to set up its overseas headquarters in Kuala Lumpur (10 Sept 2016)

Southeast Asia Glass Coating Market Overview

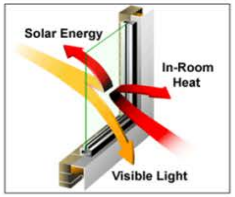
- **Market is growing!**
- **Technology is old!**
- **Very few R&D in glass coating industry!**
- **Very few R&D in university and RIs!**

Major Trends in Glass Apps


Nanotextured glass


DSSC-PV glass


Directional glass



Low-E glass


Anti-Noise glass


Silkscreen Fritted glass

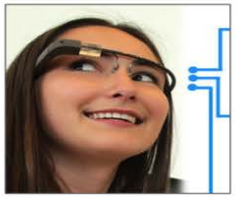

Glass Table Display


Glass Wall Display


Glass Stove Heater


Glass Hand Display


Glass Watch Display


Glass wear Display


Hydrophobic Glass

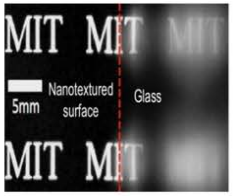

Ultra-Glossy Glass


Hydrophilic Glass


Anti-Dirt Glass


Anti-Glare Glass

Flexible Glass



Anti-Fogging Glass

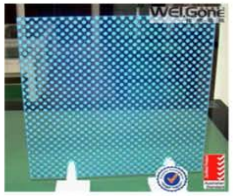
Anti-Scratch Glass

Anti-Oil Glass


Anti-Stain Glass

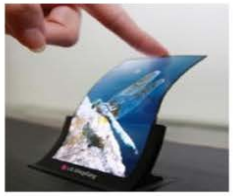

Anti-Water Glass

Ultra-thin flat glass


Anti-glare Fritted glass


Solar-control tintable glass


Shock-proof hard glass


Ultra-thin flexible glass


Anti-shatter hard glass


Anti-reflection AR glass

Glass Coating R&D in Singapore

Building and Construction Authority

BCA SkyLab is a state-of-the-art rotatable test facility pivotal to developing innovative energy efficient building technologies.

SINGAPORE

Institute of Materials Research and Engineering
A*STAR

New functional glass coating: materials & process

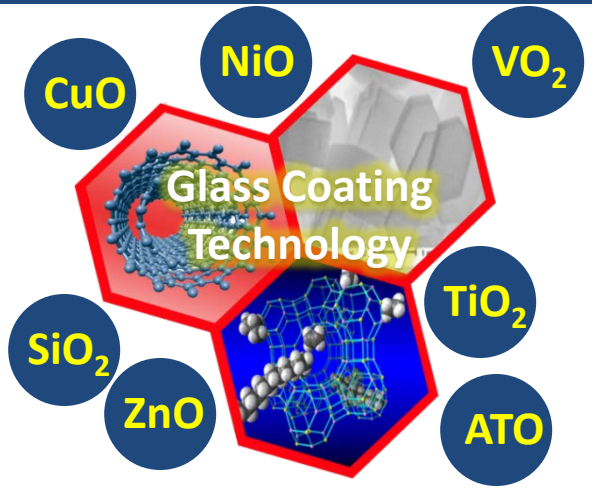
Institute of Chemical and Engineering Sciences
A*STAR

Experimental Power Grid Centre (EPGC)

Institute of High Performance Computing
A*STAR

Green Building Environment Simulation Technology

Existing IMRE Technology



C&EN CHEMICAL & ENGINEERING NEWS

CHANNEL NEWSASIA

IET AWARDS The Institution of Engineering and Technology

ScienceDaily® Your source for the latest research news

The American Ceramic Society www.ceramics.org

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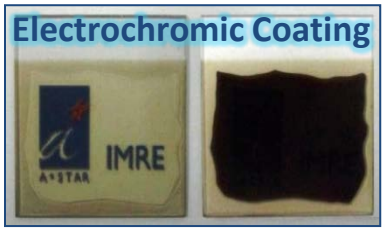
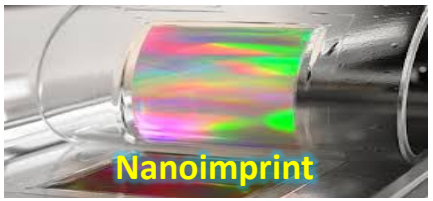
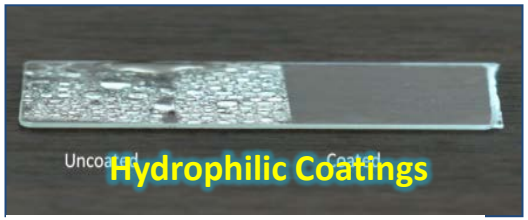
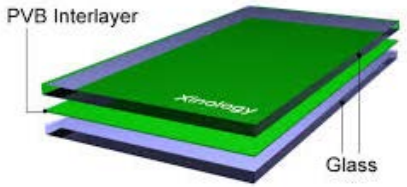
THE STAR ONLINE

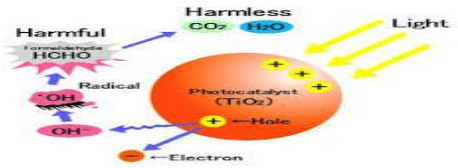




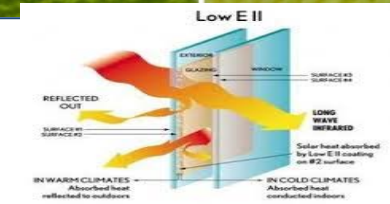




Laminate coatings

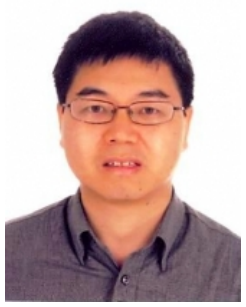


Photocatalytic coatings



Thermal reduction coating

Dr Karen Chong



Dr Xu Jian Wei

Dr Li Xu

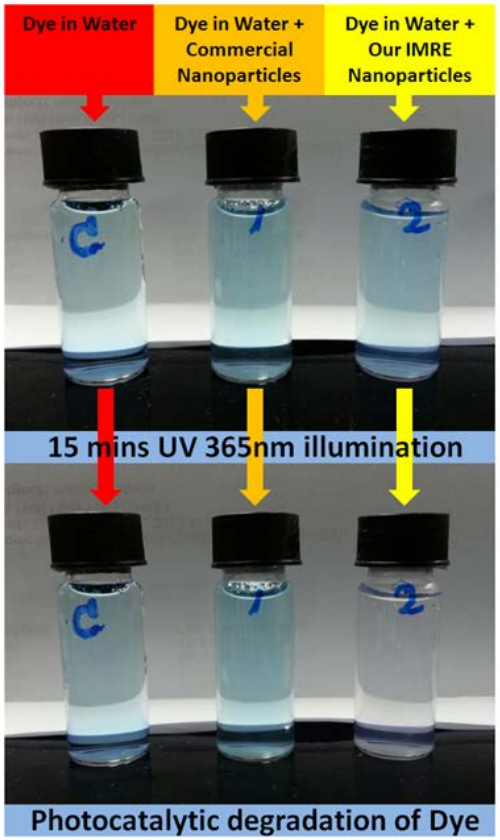
Dr Wang Shijie

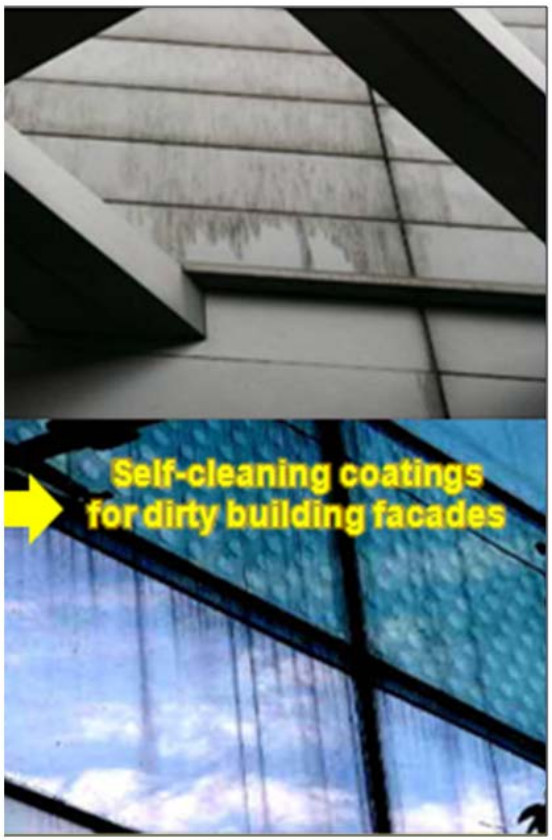
Dr Gregory Goh

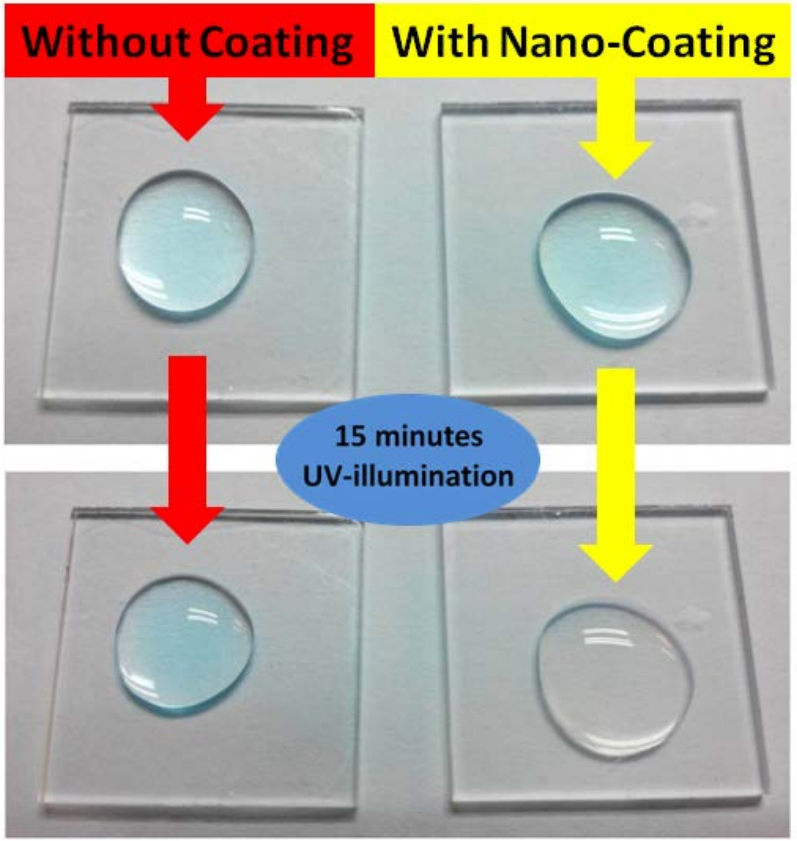
Dr Chiam Sing Yang

Dr Shah Kwok Wei (NUS)

Self Cleaning Glass (Smart Glass)



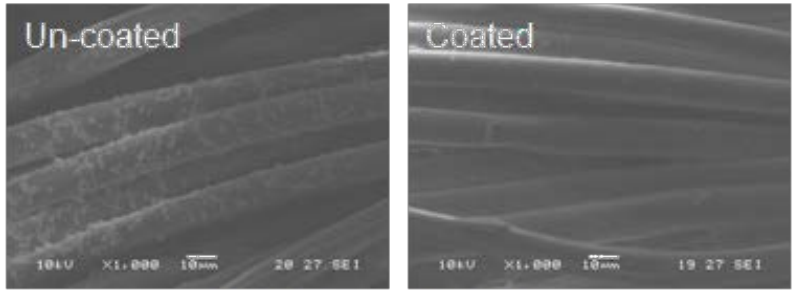




Patent:
A method to develop glass coating with self-cleaning, UV-cutting properties (Patent filing in progress)

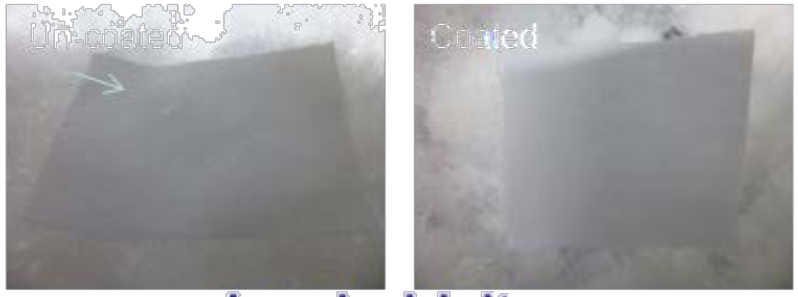
Test Results:
ISO10678 (Degradation of Methylene Blue Dye)

Hydrophobic Coating (Smart Coatings)



Antibacterial

Self-cleaning



Icephobicity

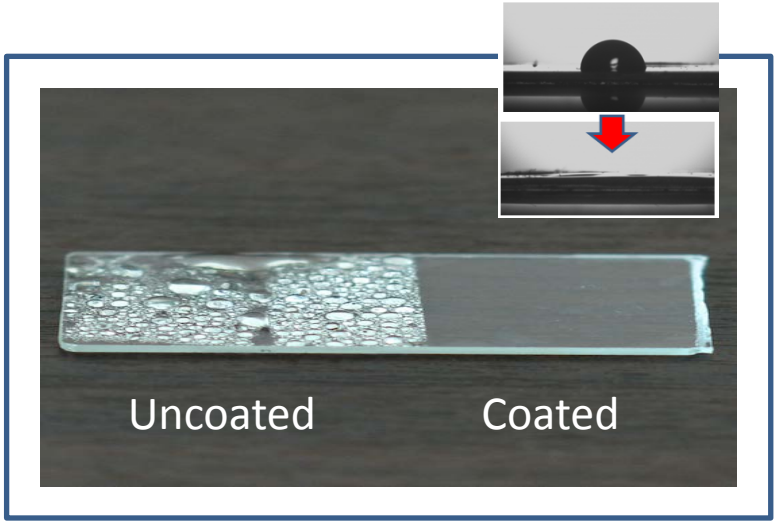
Anti-contamination

Nanomaterials for Green Building Industry

(Super-hydrophilic inorganic coatings for window glass)

Super-hydrophilic coating for self-cleaning anti-fogging application, improved visibility

- **Fully inorganic and highly transparent coating deposited on glass/plastics <100°C in a low-temp water-based chemical bath**
- **"CleanClear"** this non-UV activated coated can be used indoors and low/no light environments and has been featured in The Straits Time, Business Times, Chemical Daily (Japan), Phys.Org, Science Daily, Ceramic Tech Today (ACerS online)
- Licensing evaluation by >20 companies.



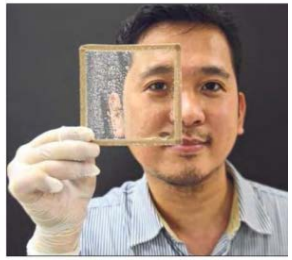
Wide International Media coverage

PHYS.ORG

New technology stops plastic, glass surfaces from fogging up

CleanClear, a hardy, permanent ceramic coating creates a layer of water to prevent fogging

By NISHA RAMCHANDANI



Clean and clear: *An IMRE researcher with a sample of glass coated with CleanC on the right side compared with the uncoated part on the left*

The American Ceramic Society

ScienceDaily®

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Clear view for drivers with S'pore invention

Special coating on windscreen keeps it clean and fog-free on rainy days

By AW CHENG WEI

MOTORISTS may no longer be hampered by rainy windscreens, thanks to a special coating created by a team of Singapore scientists.

CleanClear is a permanent ceramic coating that keeps reflective surfaces clear by attracting – rather than repelling – water droplets. The hydrophilic coating allows for a thin, uniform and transparent layer of water to be formed on surfaces, preventing fogging. The thin layer of water also helps the glass to clean itself as dirt and dust do not stick to it and wash away.

It was developed by scientists from the Institute of Materials Research and Engineering, who claim it can also be used for surfaces such as mirrors, spectacles and covers for cookware.

The institute – part of the Agency for Science, Technology and Research – is in talks with companies to further develop and license its patented technology.

While there are other similar coatings that use water for clarity's sake, they are often processed at high temperatures and can be activated only by ultraviolet rays or sunlight. This has hindered their commercial use.

CleanClear, however, works even at night and is more durable, the scientists claim. It could be used to create a vision shield for cars during heavy rain, said Dr Gregory Goh, the lead scientist who developed the technology last year.

"Conventional technologies mainly use organic-based materials and some with nanoparticles, but these do not last long and need to be re-coated from time to time," he said. The CleanClear coating becomes part of the surface permanently.

He added that the simpler processing and one-time application of the durable coating will significantly reduce the manufacturing and, ultimately, product costs.

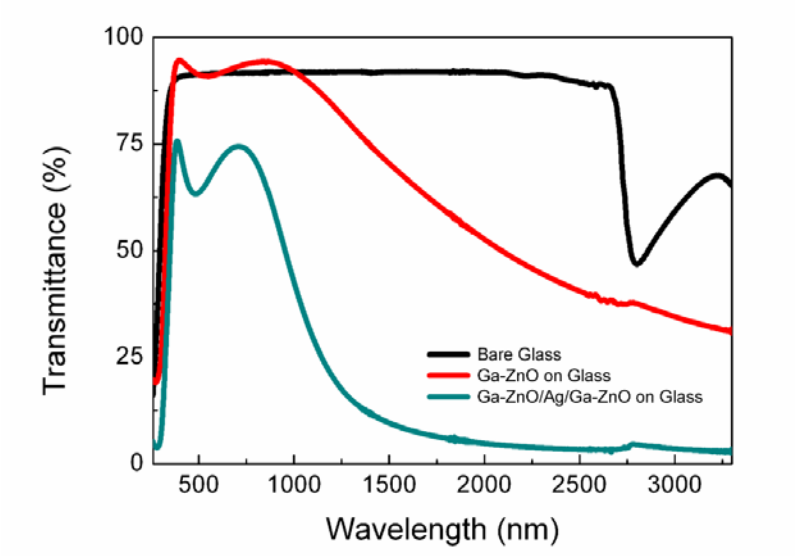
Glass companies have welcomed the new technology.

Mr Ian Lee, 34, operations director of Meng Heng Glass, said: "We can offer our clients more options with CleanClear. Some people prefer to use self-cleaning glass in areas where it is not easy to clean."

Mr Dave Lee, 41, market development manager of Solutia Singapore, said: "As long as CleanClear can prove its effectiveness and durability, there will be potential markets in building facades, shopfronts and shower screen segments."

Electrical Conductive Glass (Smart Glass)

High transparent conductive ZnO films grown at room temp.

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Low-temperature method 'grows' transparent zinc oxide films for use in displays, solar cells

April 12, 2012

The displays on flat-screen TVs and smartphones, as well as the panels on solar cells, all require materials that not only conduct electricity but are also highly transparent to visible light. One transparent electrical conductor that is typically used in the industry is indium tin oxide (ITO). Unfortunately, ITO is not only expensive but also toxic to the environment.


ScienceDaily

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Science News

Electronics: Low-Temperature Method Could 'Grow' Transparent Zinc Oxide Films for Displays and Solar Cells

ScienceDaily (Apr. 12, 2012) — A low-temperature method could be used to 'grow' transparent zinc oxide films for use in displays and solar cells.

The displays on flat-screen TVs and smartphones, as well as the panels on solar cells, all require materials that not only conduct electricity but are also highly transparent to visible light. One transparent electrical conductor that is typically used in the industry is indium tin oxide (ITO). Unfortunately, ITO is not only expensive but also toxic to the environment.

In a significant step forward in the field, researchers from the A*STAR Institute of Materials Research and Engineering and the A*STAR Data Storage Institute have now pioneered a low-cost methodology for the

A low-temperature method could be used to 'grow' transparent zinc oxide films for use in displays and solar cells. (Credit: Image courtesy of The Agency for Science, Technology and Research (A*STAR))

Publications and Patents:

- *Wong, L. M. et al. Solar Energy Materials and Solar Cells 95, 2400 (2011).*
- *Wong, L. M. et al. Appl. Phys. Lett. 98, 022106 (2011).*
- *Patent: A method of improving the transparency and conductivity of transparent conducting oxide for various applications, SG 201203481.*
- *Patent: Method to fabricate highly conducting and transparent zinc oxide at room temperature SG 201105713.*

Performance Comparison:

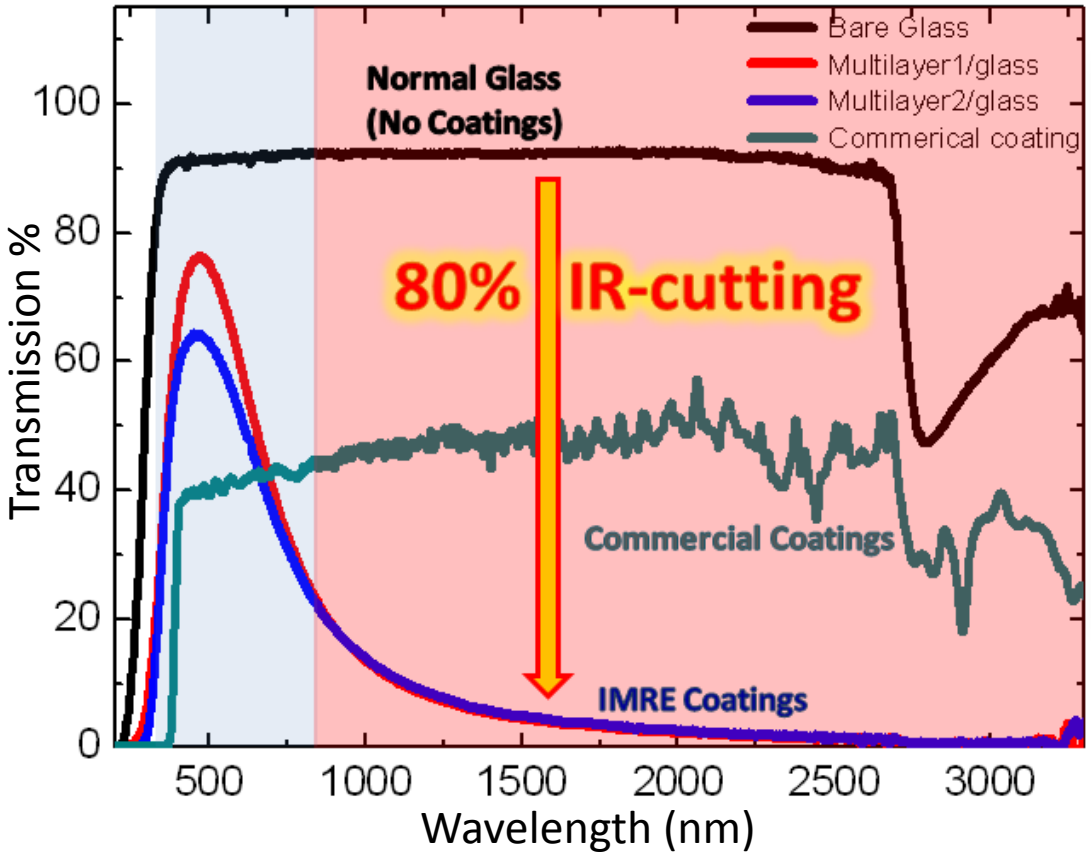
- **Ga-ZnO on Glass**
  Transparency ~ 90% *Sheet resistance 23.59 ohm/sq*
- **Ga-ZnO/Ag/Ga-ZnO on Glass**
  Transparency ~ 70% *Sheet resistance **9.38 ohm/sq***
- **Conventional Product ITO/Glass (with PDA at 300 °C)**
  Transparency ~ 80% *Sheet resistance 17.47 ohm/sq*

Applications:

- Transparent conductive electrode for solar cell, display, OLED, optoelectronics, consumer electronics.
- Heat rejection window coating for automotive, building, etc.

Solar Cool Glass (Smart Glass)

IR heat rejection glass coating for green building and car window applications

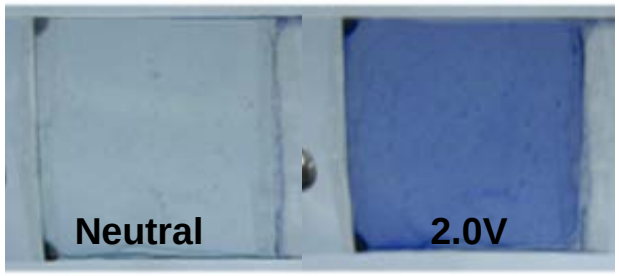


12°C Temperature Difference for Coated and Uncoated glass

- *Multilayer Structure for IR Glass Coatings (US and SG Patent Application No.13/893,024)*
- *A Method of Improving the Transparency & Conductivity of Transparent Conducting Oxide (SG Patent No. 201203481-5)*

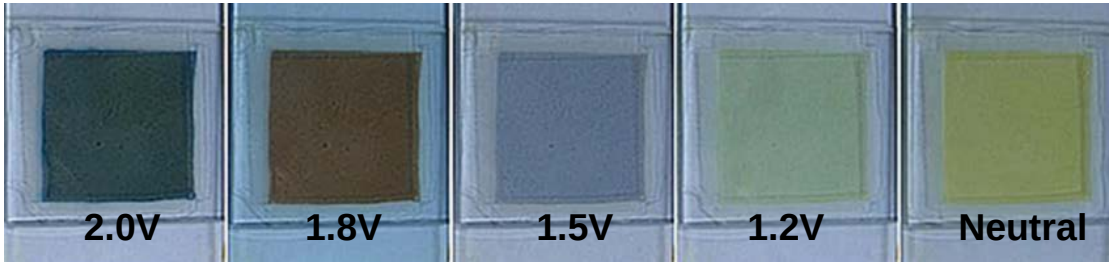
Electrochromic Glass (Smart Glass)

Single-chromic behavior

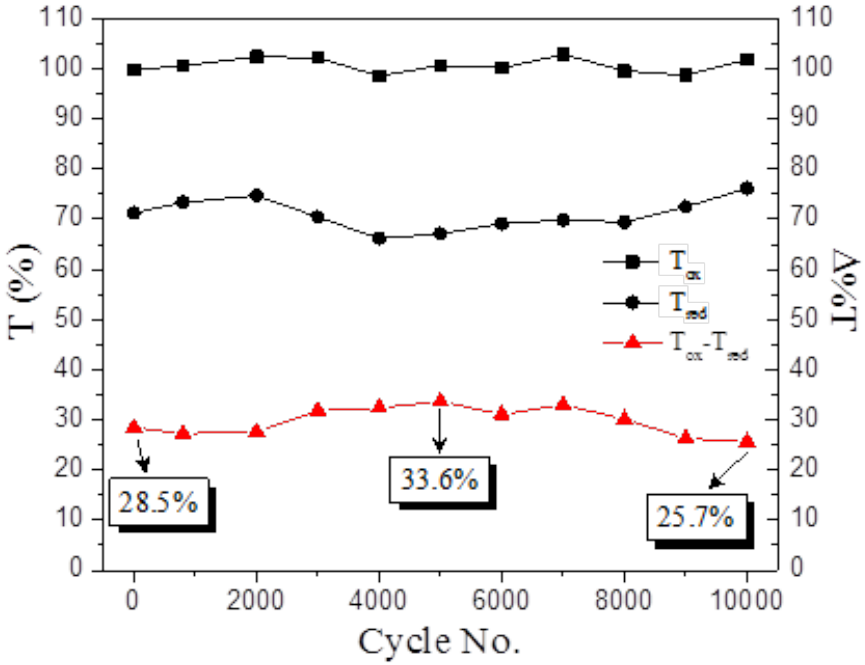


Dual-chromic behavior

Multi-chromic behavior



Long term stability / durability (10000 on-off cycles)

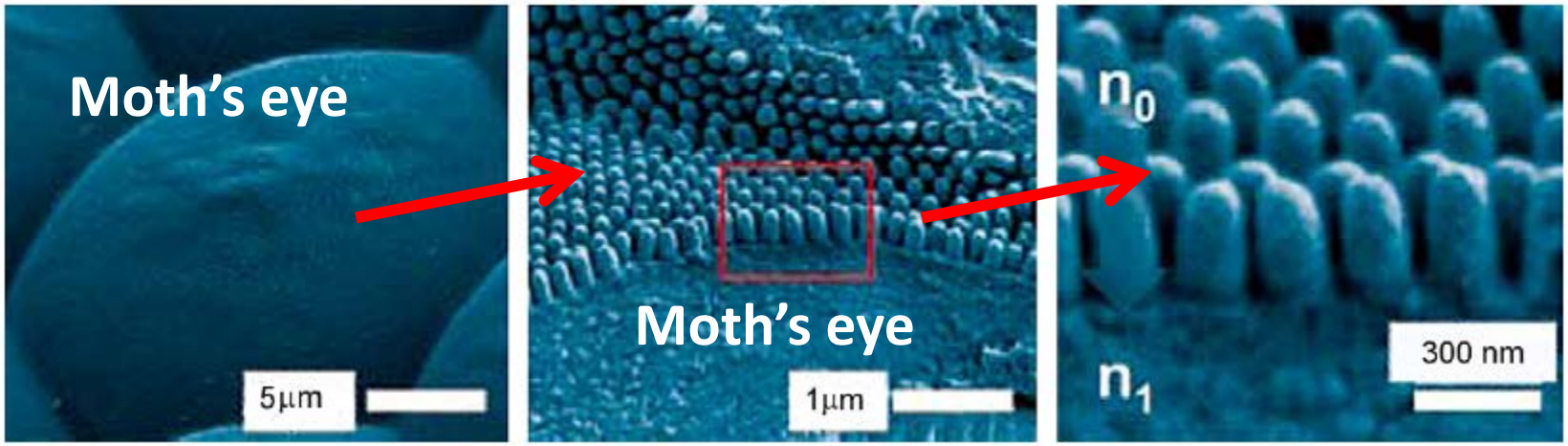


Challenges & Opportunities:

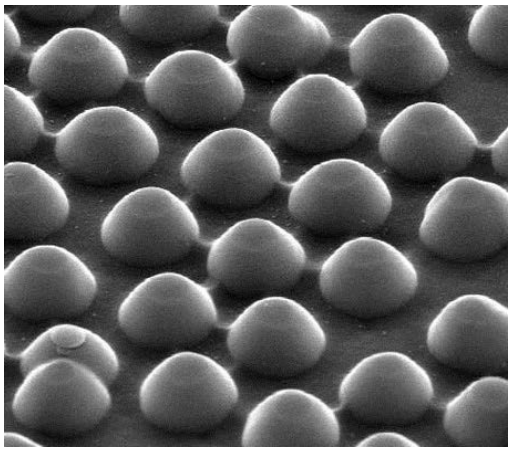
- ✓ New electrochromic materials with long-term stability
- ✓ Large area device fabrication
- ✓ Performance-morphology

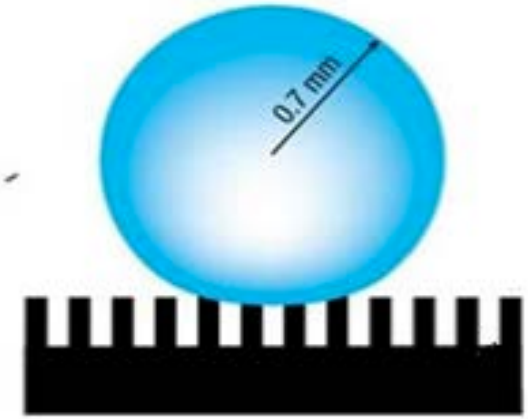
Nanoimprint (Smart Glass)

Anti-Reflection Glass (Nanotextured Glass)



Self-Cleaning Glass (Nanotextured Glass)

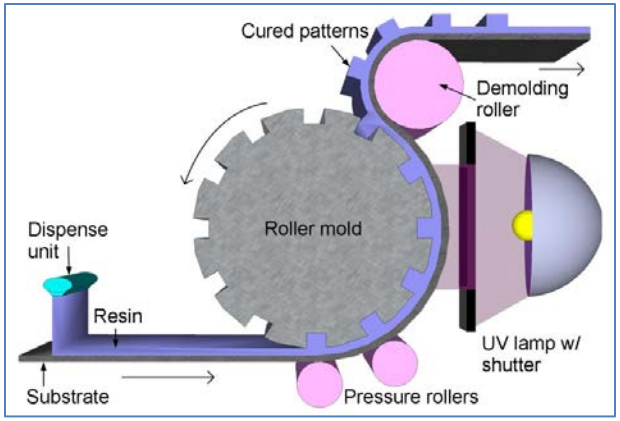




Nanoimprint Foundry

Substrates: Flat GLASS and ultra flexible GLASS (Willow Glass)

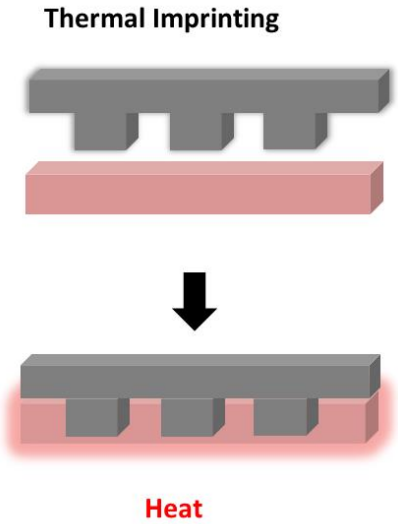
Applications: Super hydrophobicity, optical properties (improved ant reflectivity, transmission, 3D auto stereoscopy), antibacterial, biomedical (glass fluidics)



1) Area of collaboration: Flexible Glass Imprinting

Strength and flexibility of substrate will enable patterns to be imprinted onto glass via roll to roll (mass throughput) techniques.

- *Area of focus : Resins for flexi glass imprints, process optimization for flexi glass imprinting.*



2) Area of collaboration: Direct Glass Imprinting and Fabrication of High Temperature Templates

Direct imprint on glass by-passes resins required and serve as permanent fixtures on glass

- *Area of focus : Functionalities on glass with no weakness relayed to substrate ? High temperature templates (for glass and metals)*