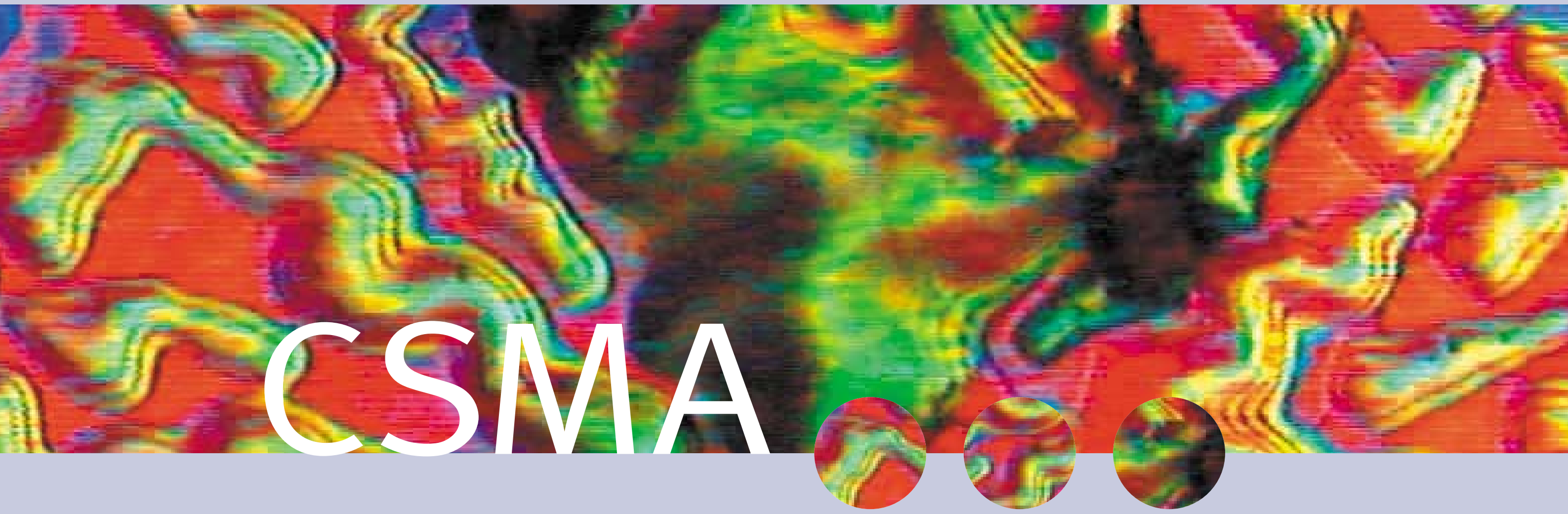
TOTAL SOLUTIONS FOR
THE GLASS INDUSTRY



CSMA

The invention of the float glass process, followed by curtain wall glazing systems has led to the incorporation of large areas of glass products in the design of many large buildings. The poor thermal performance of float glass, however, prompted the development of thin layer coating systems for glass to improve energy conservation. In Europe, approximately 90% of all glass windows sold are coated. The appearance and performance of glass is therefore paramount in modern building technology. The case studies below illustrate the application of modern surface analysis techniques to characterising glass surface and coating integrity.

BENEFITS TO CUSTOMER

- Rapid identification of manufacturing defects, corrosion processes and cleaning problems
- Characterisation of coating layer integrity including impurities and contaminants
- Settling of commercial liability disputes - Expert Witness
- Reverse engineering and analysis of competitor products

CASE STUDY

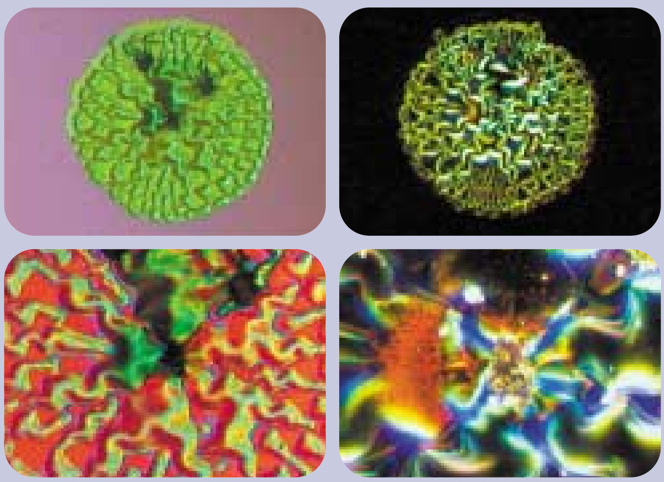
INVESTIGATION OF MULTIPLE DEFECTS ON A COATED OPTICAL FILTER GLASS

Circular defect features were observed on the surface of an optical filter product during long term storage after production. The defects were typically ~200µm in diameter and the manufacturer observed a correlation between the rate of defect formation and storage conditions. Typically, the failure rate increased with ambient humidity whereas drier conditions or encapsulation reduced the rate. CSMA's task was to identify the cause of defect formation.

The optical filter structure is based on a glass substrate, coated with a thin layer of silicon, followed by a multi-layer stack containing successive layers of yttrium oxide, zinc sulphide and silver.

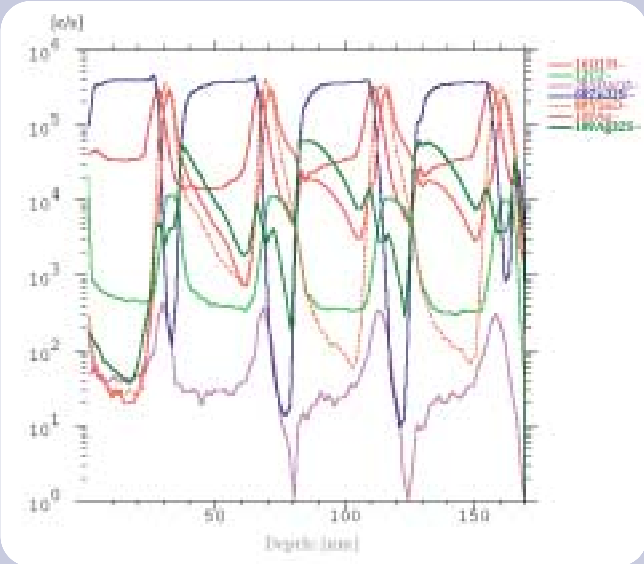
Initial investigation of the defects by optical microscopy (see right) showed the following features :-

- All defects are circular with a particulate-like feature in the centre ~1 - 5µm in size.
- Topographic information indicates that the layer structure has buckled leaving fault lines that appear to radiate from the centre of each defect.



Optical Microscopy images of a defect - field of view is 400µm (top left and right), 200 µm (bottom left) and 100 µm (bottom right).

CASE STUDY

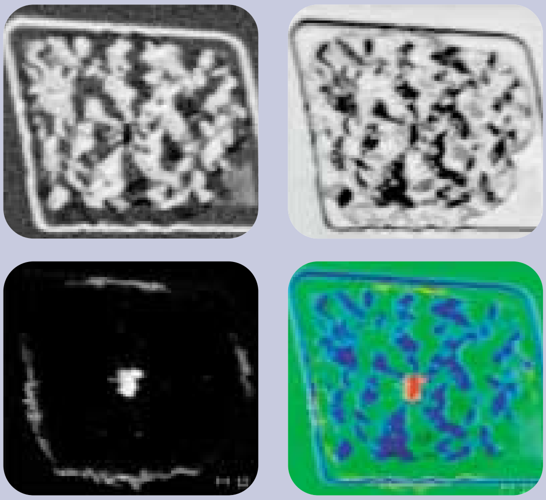


SIMS depth profile analysis of a non-defect area of the filter (left) clearly shows the alternating layer structure :-

- The individual layer thicknesses are ~10nm for silver and yttrium oxide layer and ~30nm for zinc sulphide.
- Formation of silver sulphide has occurred through chemical interaction between the adjacent silver and zinc sulphide layers.
- Carbon contamination is present at or near to the silver / zinc sulphide interfaces. This is probably a result of poor vacuum quality in a reactor vessel.
- OH is found in the zinc sulphide layer and particularly at the zinc sulphide / yttrium oxide interface. Again this may be indicative of poor vacuum quality during layer deposition, or moisture ingress post-production.

Progressive SIMS image acquisitions through a defect area (right) show the buckling and displacement of the layer structure and the probable cause of defect formation :-

- A silicate-rich particulate is found at the centre of the defect area at the interface between original glass substrate and the coating layer structure.
- Localised physical stresses in the coating, caused by the particulate and expansion of any associated moisture, result in the eventual distortion of the coating, radiating outwards from the nucleation site.



SIMS images of defect area showing yttrium oxide (YO_2^- - top left), zinc sulphide (ZnS^- - top right), silicate (SiO_3^- - bottom left) and overlayed (bottom right).

On CSMA's recommendations, based on this work, a more rigorous cleaning and inspection process for the glass substrates was implemented by the manufacturer, resulting in subsequent yield improvements.

CSMA provides a complete surface analysis service to industry to accommodate every level of demand:

- rapid turnaround analysis (24 hours)
- problem solving and failure analysis
- litigation and expert witnesses
- training courses
- reverse engineering and competitor analysis
- materials and product development
- patent registration / infringement

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CSMA
experts in surface technology

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