Spontaneous failures

Examining the key issues facing the glass and glazing industry, glass technologist, Dr. Richard Cave, looks at NiS inclusions

Working with manufacturers, architects, estate managers, installers, specifiers and designers, we're only too acutely aware of the issues facing the glass and glazing industry and failure analysis remains high on that agenda.

Our team is kept busy both on-site and in our dedicated laboratories with the identification of defects such as inclusions, bubbles and scratches and identifying failures due to external influences such as thermal stresses and impacts. Knowledge and experience combined with modern analytical techniques, allow us to identify failure origins and determine reasons for failure in all types of architectural, automotive and domestic glazing.

A substantial portion of our work involves analysing toughened glass. The industry knows that thermally toughened glass has numerous benefits over annealed and heat-strengthened glass; including better resistance to thermal changes, increased strength and safe breakage characteristics, but despite all these benefits, toughened glass is at risk from one unique fatal flaw: an inclusion of foreign material, just a few hundred microns in diameter.

"Despite all these benefits, toughened glass is at risk from one unique fatal flaw: an inclusion of foreign material"

Nickel Sulphide (NiS) inclusions were discovered in the 1960's by E.R. Ballantyne, after his investigations into the spontaneous failures of glazing in the ICI House Building in Melbourne, Australia. In the decades since this discovery, steps have been taken to eliminate NiS inclusions from the production of float glass, with changes in raw materials supplies and shipping methods, manufacturing methods and processing techniques, but even today, failures due to NiS still occur. So why is NiS specifically such an issue?

Time bomb

The presence of NiS in annealed float glass does not ordinarily present a problem; it is only during the toughening process when the glass is heated and then rapidly cooled, that a phase change in NiS particles present within glass occurs, effectively creating a 'time bomb' for the failure of the glass.

Over time the NiS will slowly grow, and over a period of anywhere from a year to twenty years, or longer, the inclusion will generate enough localised stress in the surrounding glass to cause cracking, resulting in the spontaneous failure of the whole panel.

In order to attempt to 'weed out' glass panels contaminated with NiS inclusions, heat soaking processes were developed, such as that introduced by Pilkington in 1969, and are now recommended for all glazing installed in critical locations such as barriers or overhead glazing. The process outlined in the standard EN 14179-1 (Glass in building. Heat-soaked thermally-toughened soda lime silicate safety glass), is not considered to be 100% effective, but processing glass in accordance with this standard will typically reduce the likelihood of spontaneous failure in buildings due to NiS.

Ultimately, architects, engineers and specifiers should consider the benefits and drawbacks of all types of glazing before installation, and ensure that they adhere to the appropriate sections of Building Regulations Approved Document K and Codes of Practice such as BS 6262-4:2005 (Glazing for buildings code of practice for safety related to human impact) and BS 6180:2011 (Barriers in and about buildings code of practice)

It should also never be assumed that the seemingly spontaneous failure of a toughened glass panel is due to NiS inclusion. Numerous other factors could be involved, such as non-NiS inclusions, vandalism, design flaws, poor toughening, edge damage and damage due to contact with fittings and fixtures. Any spontaneous failure of a toughened panel should undergo a comprehensive analysis to determine the true cause or causes.

Our teams often analyse glazing failures on site initially, before examining fragments in the laboratory. Combining observations and measurements made on site with the analysis of failure origins allows us to provide clients with a comprehensive report detailing the cause of failure.

For more information, visit: www.glass-ts.com/architecture-and-glazing or, email: enquiries@glass-ts.com