# HST provides Invisible evidence, visible proof

Thomas Rainer
**bora***ident* Gmbh


Apart from the appreciated lightness and transparency, glass inside buildings and on facades convey the impression of beauty, and strength. But even that strong material could fail. Reality shows that in certain cases, where parts of facade glazing are breaking and come tumbling down – resulting in additional costs that need to be covered, also to a lack of confidence and the question of responsibility.

Although manufacturers and constructors have done their very best to ensure the high quality standard of their prestigious systems – failure of the dynamic glass material could become a harsh and bitter reality.

In the following article we analyze one of the main reasons for this problem: the nickel sulphide-induced failure of glass. We focus on the importance of relevant documentation and factual evidence, we also show methods to ensure legal certainty to manufacturers, suppliers and all other intimately concerned parties of Heat Soaked Tempered Glass (HSTG).

## Spontaneous breakage / NiS inclusions

Spontaneous glass breakage is a phenomenon by which toughened glass may spontaneously break without any apparent reason. In many cases this is caused by the inclusion of nickel sulphide (NiS) – small particles that infect the glass melt inside the furnace during the manufacturing process.

These NiS inclusions ("stones") are generally of 50 to 400 µm in size, far too small as to be visible to the human eye. However, once embedded in the tensile zone of the tempered glass substrate they can develop their own troublesome and destructive forces.

Depending on time and temperature, NiS transforms from α-configuration (high-temperature phase) to β-configuration (low-temperature phase). During the tempering process, the glass (with the embedded NiS particle) is heated above the glass transformation temperature which converts the particles to α-NIS. But when the glass gets quenched (rapidly cooled down) to create the desired internal stresses, it takes only a small amount of NIS to re-transform from α-NIS to the β-type so that the rigid tempered glass contains initially a bigger part of α-NIS. But the recrystallization to β-NiS is slowly continuing, even at room and/or outdoor temperature. And due to the fact that the particles change their structure during this process, further internal stresses could appear – even after many years. Depending on their size and position inside the tensile zone, the glass could fail if their stresses exceed the stength of the glass – beakage results.

## HSTG

Regardless of whether the contamination is affiliated to the raw materials or the actual production equipment, its prevention or avoidance would require a disproportionately high – and thus expensive - effort. Hence, NiS contamination which leads to the failure of glass presents a ubiquitous and unpredictable risk for all manufacturers of tempered glass and all subsequent partners along the value chain. It naturally follows that special provisions are fixed by law for overhead installation of glass or the usage of such in public areas (European standard DIN EN 14179-1). It includes amongst others, that only a specially treated glass type must be used: HSTG.

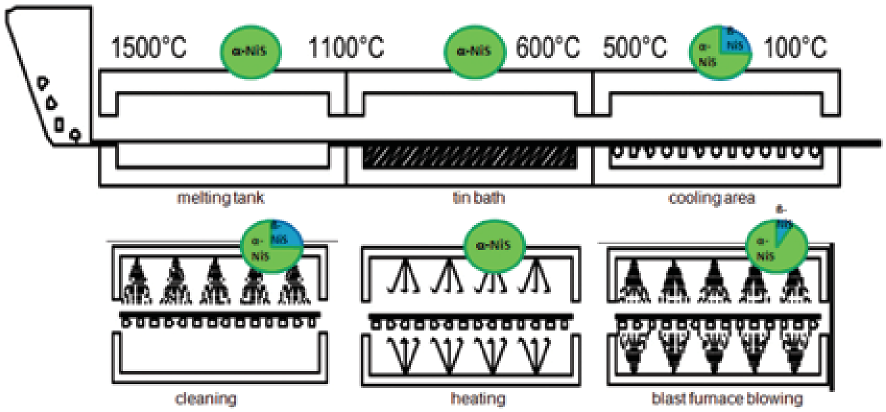



**Fig 1: Development of NiS-inclusion in the manufacturing process of tempered glass**
*Source: Prof. Dr. J. Schneider, Technical University Darmstadt*

In order to make spontaneous glass breakages due to NiS inclusion less likely and thereby reduce the frequency of this unwanted phenomenon, toughened glass should undergo a special treatment: the appropriately named Heat Soak Test (HST).

This is a process which, when properly performed, can destructively uncover most NiS inclusions, if there should be any present. This Heat Soak Test involves the glass panes being placed in a special heat soak chamber and subjected to a temperature of 280 - 300°C (540 – 570 F) over a time period of 2 to 4 hours (depending on local regulations).

The heat treatment accelerates the NiS transformation process and causes the expansion of potential inclusions that lead to a desired breakage of the „infected" pane.

Thus, the HST process ensures only a minor risk of failure for the residual panes. This remaining risk, commonly known as „probability of failure" is only slight, but it still differs from zero probability. It is estimated with about 1% per annum. According to Bauregelliste 2002/1 of the German Construction Authority, this probability of failure is attested as product characteristics.

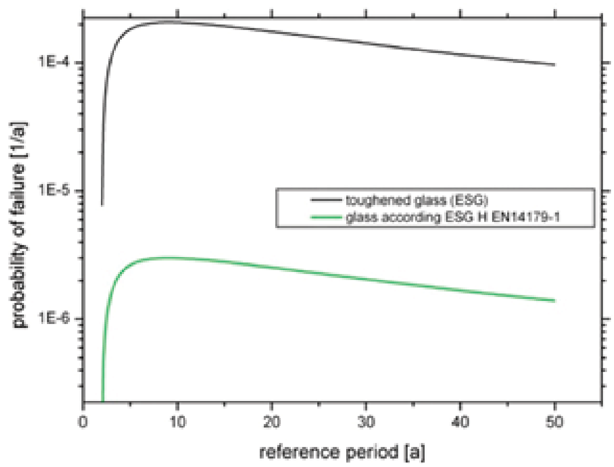



**Fig 2: The diagram shows that the „probability of failure" for Heat Soaked tempered glass reduces to one third of the one of tempered glass.**
*Source: Prof. Dr. J. Schneider, Technical University Darmstadt*

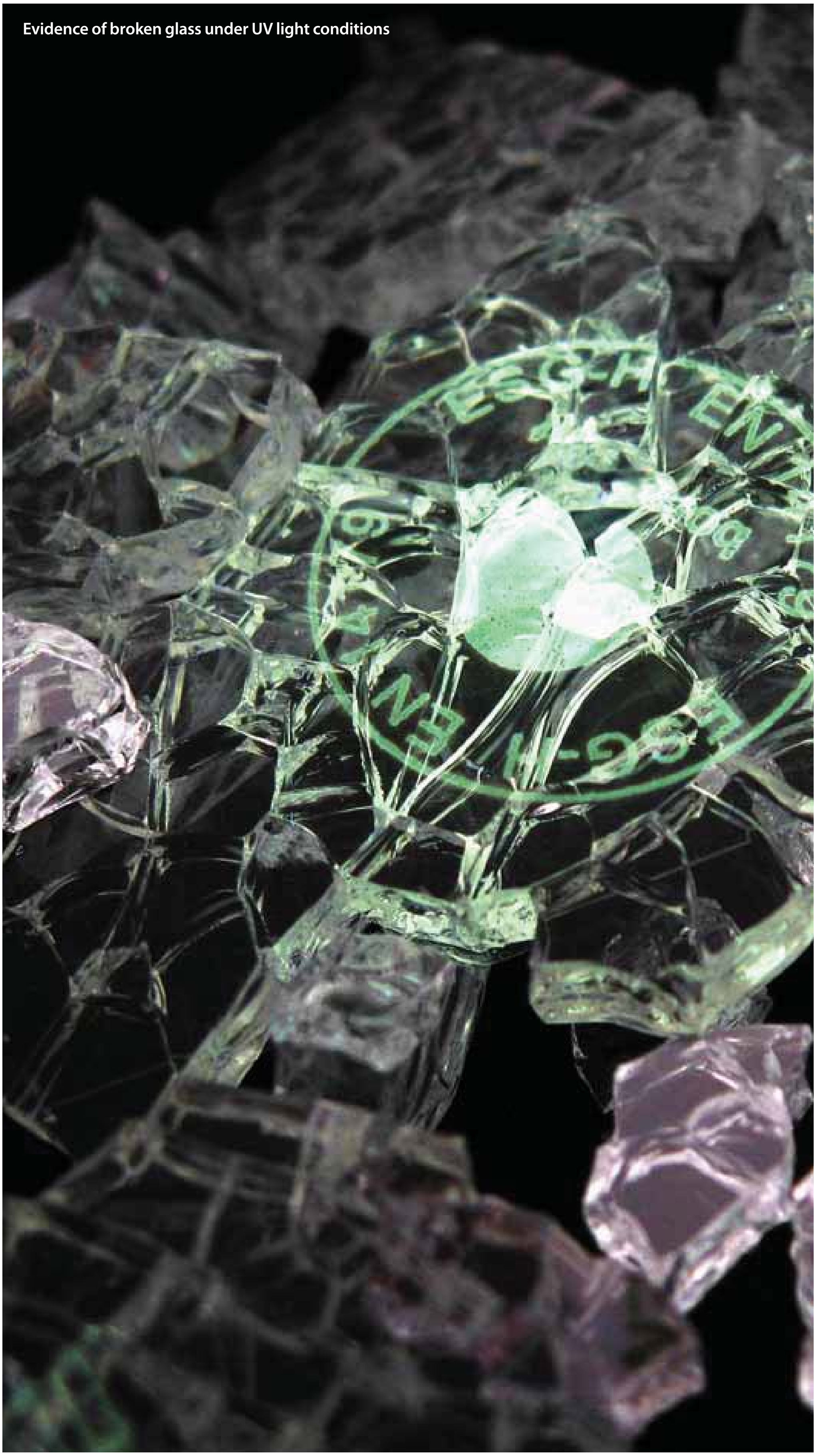
### The legal situation in Europe and legal decisions made in Germany

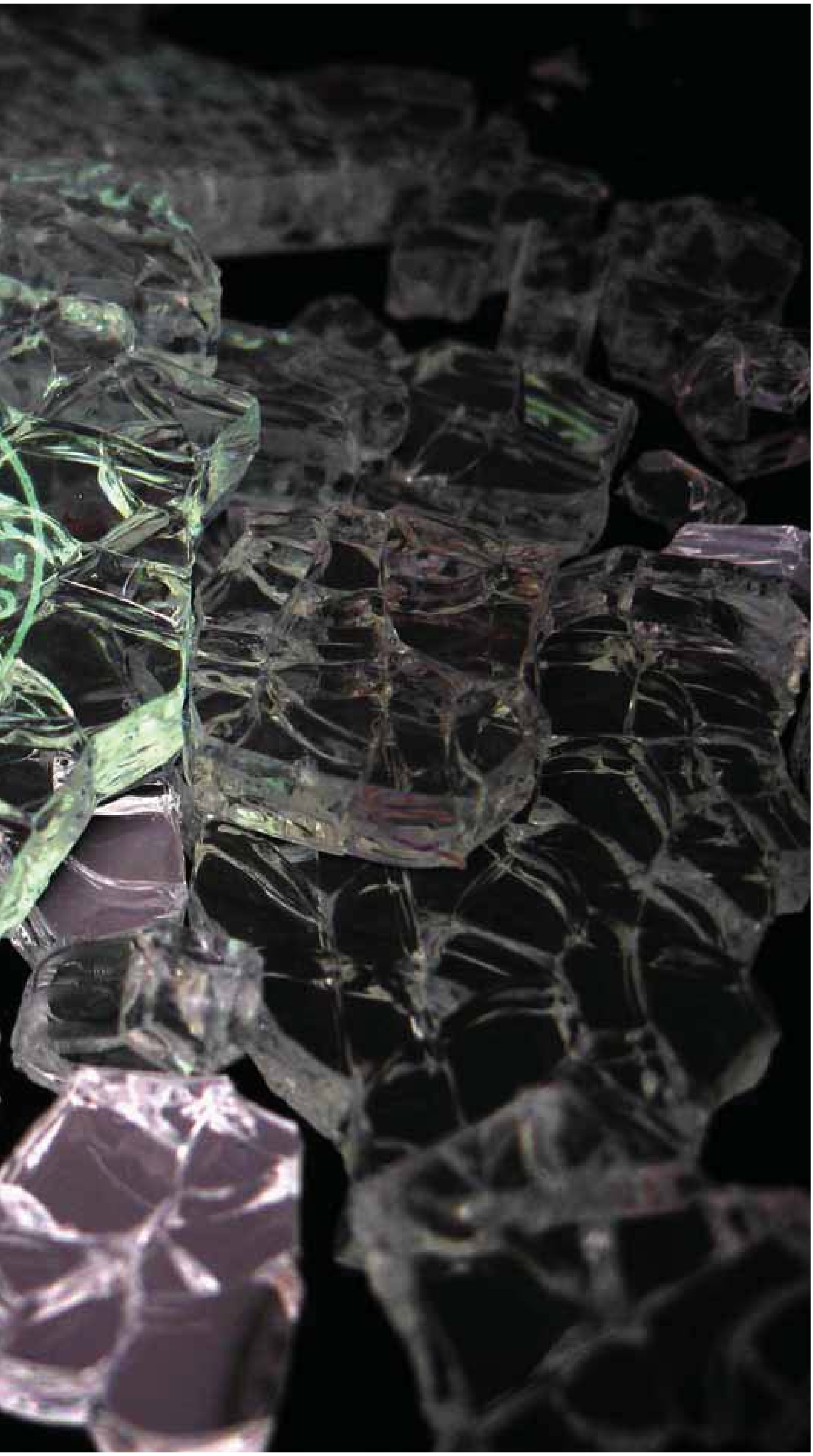
According to EN 14179, manufacturers must prove that every as of ESG-H (heat-soaked tempered glass) declared pane has passed the Heat Soak Test. According to the product standards, which may differ from country to country, the manufacturer is held responsible for the correct execution of the HST process and all relevant documentation. In the case of breakages after installation and resulting in damages, the manufacturer's evidence will be the basis for any legal decision making. Only complete and unambiguous documentation keeps the manufacturer indemnified against all liability from accidents and injury.

Reality shows that a lack of evidence creates an ambiguous situation in many legal cases. In the event of damages due to falling glass elements, referees might verify at first, if the required HSTG has been used. In the next step, the manufacturer or constructor has to provide evidence that the used charge had completely passed the Heat Soak treatment – usually by submitting the entire documentation, the so called "oven protocols". This complete documentation will support decisions on liability in cases where damage has occured; it consequently follows that incomplete evidence inevitably leads to considerable claims for compensation.

So decided the Regional Court in Dresden (Germany) that "…those glass elements are insufficient, whose Heat Soak treatment cannot be proven. It is not possible to assign the manufacturer's documentation to the respective shipment" (OLG Dresden Az 14 U 912_08).

Another case led to the manufacturer's fate when it was decided „…the oven protocol must be replicable to every single glass pane" (LG Düsseldorf Az 1 O 472-08). The first instance for investigation is the construction company who must submit the ‚certificates of compliance'. If they can provide evidence by means of complete documentation, sometimes, the surveyor draws samples by inspecting the glass manufacturing plant. In many cases that have resulted in claims for compensation, the complete documentation could not be found or reconstructed and so was simply forged. In any case: whoever will be found culpable for compensation purely on the basis of incomplete or inexplicable documentation,


Evidence of broken glass under UV light conditions



will certainly be facing considerable financial strain. As usually, the company is not only held responsible for replacing the defective glass, but also for secondary losses: property damages, reproduction costs, downtime compensation et al.

**One possible solution: Evidence on the glass itself**

But how is it possible to furnish clear and unquestionable evidence that the glass – and better: every single glass pane - has successfully passed the Heat Soak treatment? It was only a few years ago that thermochromic inks were established in order to prove the correct treatment on the glass itself. This ink gets applied on the glass itself before and then changes colour during the process.
There is a new, sophisticated technology available to the free market in the form of the HST checkmarker® ink. Apart from the thermochromic attribute it offers a second feature: under HST conditions, the UV-active ink creates a resistant fluorescence marking inside the glass material. Thus, it guarantees several additional benefits: After applying the ink with a pen or a stamp, every pane is individually marked. Under the Heat Soak process, this mark changes colour – in the production environment this is a visible reference that the pane has passed the necessary process. This surface coating can be removed when installing the glass pane in order not to affect the product aesthetics. But the proof remains throughout the product life-cycle in the form of a long-term resistant, unambiguous fluorescence marking which can be visualized only under UV-C-radiation. Even after spontaneous breakage of the pane, evidence that the Heat Soak Test has been undertaken and passed, can be very easily provided. Manufacturers of heat soaked tempered glass do not only benefit from peace of mind with this legal certainty, the invisible evidence on the pane itself is also an appreciated selling point.

**boraident GmbH**

**bora***ident* GmbH is an innovative technology and engineering company located in Halle (Saale), Germany. It develops products and solutions for customer-specific applications on glass and other transparent media. In the areas of laser marking, laser structuring and optical and chemical glass sensoric, **bora***ident* offers sophisticated high-performance products - with patented technologies for a reliable glass handling.