

## **Conservation of stained glass windows and microclimate: a comparison between different protective glazing systems**

*A. Bernardi and F. Becherini*

Institute of Atmospheric Sciences and Climate, National Research Council,  
Corso Stati Uniti 4, 35127 Padova, Italy

The ancient stained glass windows are composed of pieces of coloured or clear glass, assembled in a lead network and decorated by a vitrified painting (*grisaille*). Environmental factors (temperature, humidity, water, pollution, micro-organisms growth, etc.) separately or in synergism accelerate the decay of glass and its paint, through various deterioration mechanisms (leaching, development of corrosion and deposition layers that darken the glass, manganese oxidation, pulverisation or flaking of *grisaille* etc.).

The European VIDRIO project has the purpose to provide a better understanding of the effect of the environment on glass and paint from a multidisciplinary point of view (physical, chemical and biological) and to identify the best practice to preserve ancient stained glass windows in their original context.

Protective glazing is widely accepted as a preventive conservation method, but a lot of open questions still remain, in particular if the microclimate in the interspace enhances the thermo-hygrometric cycles and/or the micro-organisms growth. Moreover, previous studies prove that condensation on stained glass windows occurs, even after the installation of protective glazing, especially on the inner surface of the glazing. Hence, in addition to the more conventional microclimatic measurements, a new “dew point sensor” was developed to detect condensation on the glass surface and recently patented.

The research programme of the project foresaw experimental campaigns in two French sites, the Saint Urbain Basilica (Troyes) and the Sainte Chapelle (Paris), and in the Cologne Cathedral (Germany), the last two included in the UNESCO’s World List of Cultural Heritage.

The three monuments are equipped with different protective glazing systems, all internal ventilated. In order to evaluate the efficiency of the protective systems, i.e. whether they improve the environmental conditions and protect the ancient glass, the monitoring was performed on both protected and unprotected windows, characterized by different orientations: facing south in France, north in Germany.

The data collected are being processed and the results obtained up to now confirm that even when the protective glazing is not of the best quality, it protects the stained glass from the outdoor environmental attack from all the points of view: physical chemical and biological.

Nevertheless, the impact of the protective glazing on the microclimatic conditions of the ancient stained glass windows depends strongly on the technical characteristics of the system installed (type of glazing, size of the openings and of the interspace, kind of ventilation, etc.) that may reduce or in certain cases enhance the thermo-hygrometric stresses on the protected window compared to the unprotected one.

Anyway it need to wait the end of the research before giving final contribution aimed to find the most sustainable solutions to preserve this important part of European Cultural Heritage.