Glass-Metal Joining in Nuclear Environment: the State of the Art

M. Jacobs
SCK-CEN, Institute of Nuclear Material Science, Boeretang 200, B-2400 Mol, Belgium
marijke.jacobs@sckcen.be

In the ITER fusion machine and in material testing fission reactors, it is not possible to avoid the use of non-metallic materials like glass for example. There is therefore a need to apply metal to glass joints. This problem arose already at the beginning of the 19th century when the electric light bulb was invented. Nowadays this type of glass-metal joint is very successful and widely used in the electronic industry. In the case of ITER and material testing reactors, glass-metal joints are necessary for the fixation of the optical windows and optical fibres to a metal structure to perform diagnostics. These types of joints are still difficult to make and their behaviour is not fully understood. A joint between glass and metal for a nuclear or fusion application has indeed to resist high temperatures and high neutron fluences, while keeping a good mechanical strength and remaining leak tight. These characteristics are difficult to obtain under these severe conditions.

This paper presents an overview of the different joining technologies that can be used to join glass to metal in a severe nuclear environment. The working mechanism of the technologies are explained, together with their respective advantages and drawbacks. Three different types of joining are discussed: fastening, liquid phase joining and solid phase joining. Fastening is a mechanical attachment technique, not achieving easily hermetic seals. Liquid and solid phase joining on the other hand form a real bond, what makes the joint much stronger. The most important technologies using liquid phase joining are adhesive bonding, fusion welding and brazing. In the case of the solid phase joining the choices are ultrasonic torsion welding, diffusion bonding and electrostatic bonding. If it is usually not possible to join the glass directly to the metal, an interlayer must be used. One speaks then of indirect joining.

The paper will conclude with a discussion on the best choices for the specific examples of windows in the vacuum vessel of ITER and the use of embedded optical fibres sensors in nuclear reactors.

Number of words in abstract: 336

Keywords:
Technical area: B1. Functional materials Ceramic insulators
Special session: Not specified
Presentation: No preference
Special equipment: No special equipment