CEA Saclay –Service de Physique de l'Etat Condensé (SPEC) (page web)
Laboratoire *SPHYNX* (page web)

INTERNSHIP/THESIS PROPOSAL

STRESS CORROSION BEHAVIOUR OF MESOSTRUCTURED GLASS BY PHASE SEPARATION

Glass is a widely used material due to its many advantagious properties: transparency, hardness, low thermal expansion, high melting point temperature, relative chemical inertia, etc. However, it has one major weakness: its fragility. Relatively moderate stresses can cause it to break suddenly and without any warning. Glass is also sensitive to stress corrosion cracking: sub-crtical cracking aided by environmental conditions (relative humidity, temperature, etc.). In this case, apparently harmless stresses (much lower than those leading to its sudden breakage) can lead to crack propagation at low rates, as observed in the slow cracking of car windscreens. This stress corrosion cracking (SCC) also depends on the intrinsic parameters of the glass: chemical composition, microstructure, etc.

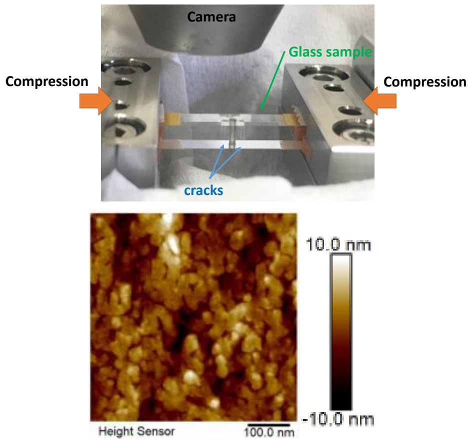

Figure 1 : Experimental set-up of stress corrosion cracking (top) and (bottom) AFM image of the fracture surface of a phase separated glass sample.

The phenomenon of phase separation in glasses leads to a meso-structured material which can improve mechanical properties such as crush resistance[1]. It is also at the origin of glass-ceramics, consisting of microcrystals dispersed in a glass matrix, developed to take advantage of the benefits of both components: ceramics and glasses. They are used, for example in optical thermometry applications, kitchen utensils, dental materials, etc. However, the stress corrosion behaviour of this type of material is still poorly understood.

The objective of this internship is to examine stress corrosion cracking in several different glassy ceramics. Samples will concern as fabricated samples and their phased separated counterparts which will be achieved by varying annealing protocols. The candidate will make use of an existing SCC experimental set-up (Figure 1 top). The rate of crack propagation and its variation with applied stress will be measured for each samples to obtain the characteristic stress corrosion resistance curves. Additionally, the candidate will have the opportunity to use a state-of-the-art Atomic Force Microscope (AFM) to characterize *post-mort*em fracture surfaces. These studies will aid in characterising the size of phase separation and will feed different statistical tools (stochastic modelling, fractal analysis).

This internship will take place in the SPHYNX lab located in the *Condensed State Physics Service* which is a joint CEA / CNRS unit (UMR 3680 CEA-CNRS). Researchers study condensed matter physics, from the most fundamental physics to industrial applications. The candidate will have the opportunity to use and learn first-hand advanced methods for characterising materials and their surfaces, from the macroscopic to the nanometric scale. The approaches will be based on experimental platforms and theoretical tools developed in-house. The candidate will have the opportunity to manipulate theoretical and experimental tools used in the field of materials science, mechanics and statistical physics. Finally, the very fundamental and applied character of this research will allow the candidate to find opportunities in the academic world (thesis) and in industry.

This intership may lead to a thesis (funding to be determined)

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[1] Feng, W et al. Stress Corrosion Cracking in Amorphous Phase Separated Oxide Glasses: A Holistic Review of Their Structures, Physical, Mechanical and Fracture Properties. Corros. Mater. Degrad. 2021, 2, 412-446. https://doi.org/10.3390/cmd2030022