Ex-situ synchrotron imaging of cracks in self-healing glassy matrix

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The self-healing in materials science is defined as the capacity to recover the mechanical integrity and initial properties of a material after destructive actions of external environment or under influence of internal stresses. The self-healing concept has been developed in many application fields such as polymers for coatings, microelectronic packaging, medical uses, concrete structures, and composites for aerospace applications. A new process that enables glassy materials to self-repair at high temperature has been developed at UCCS [1-2]. Self-repairing is obtained through the oxidation of intermetallic particles such as vanadium boride (VB) dispersed within glass matrix into V_2O_5 and B_2O_3 due to the reaction with air.
The submicronic size of the cracks excluded the analysis of the healed zone by conventional methods like SEM-EDX, X-ray diffraction or vibrational spectroscopy. In this lecture, recent results from synchrotron imaging (coupled with micro-fluorescence and diffraction) on self-healing processing in glassy materials will be presented. Several points have been clarified using synchrotron-based methods: reactivity of V_2O_5 and B_2O_3 with the glass components; state of the healing phase (amorphous and/or crystalline); information on the local morphology of the healed zone since the full filling of the crack is necessary for the efficiency of the process (Figure 1).

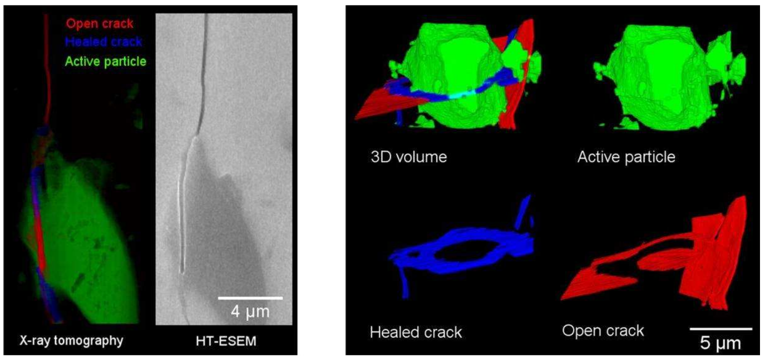

Figure 1: (left) Synchrotron imaging and HT-ESEM observation of a partially healed crack; (right) 3D reconstruction of the healed crack.

References
[1] - D. Coillot, F.O. Méar, L. Montagne, Patent WO 2010/136721 A1 (2010).
[2] - D. Coillot, F.O. Méar, R. Podor, L. Montagne, Advanced Functional Materials **20**, 4371 (2010).