Study of a glass-ceramic seal : porosity and crystallization

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Abstract

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Sealing is a major issue in High Temperature Electrolyzers (HTE) used for hydrogen production. The specifications that seals must meet are particularly demanding (thermal and chemical resistance, thermal expansion coefficient, electrical resistivity, viscosity...). These numerous constraints lead to the use of glass powder suspended in organic solvents, which is heat-treated to form a glass-ceramic seal.

Objectives of the study are to characterize and model the microstructure (porosity and crystallization) of the glass-ceramic seal. Indeed, a large and interconnected porosity can decrease the sealing properties. Moreover, a dense material will, a priori, be mechanically more resistant than a porous one. Finally, the crystallization may have a significant effect on the mechanical properties (resistance, tenacity, viscosity, hardness...).

The evolution of the microstructure as a function of temperature and duration of the heat treatment has been determined. Different crystals have been identified by X-Ray Diffraction (XRD) and electron microprobe. The crystalline surface fraction of the main phase has been determined by image analysis of SEM pictures using BackScattered Electron (SEM-BSE) detector. Its evolution has been modeled using a JMAK (Johnson-Mehl-Avrami-Kolmogorov) model which allowed to determine the crystallization kinetics. The evolution of porosity (percentage, mean diameter, number of pores) has been determined by image analysis of Scanning Electron Microscopy pictures using Secondary Electron detector (SE-SEM). This paper will present the obtained results.

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