# Hot Gas Cleaning by Porous Ceramics; the Effect of Microstructures on Degradation and Durability

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**Abstract** - Insufficient reliability of hot gas filter materials is among the main obstacles for the wider applications of porous ceramic filters in advanced powder generation processes. Multi-phase microstructures together with complex and changing service environments make it difficult to determine the degradation mechanisms of filters by failure analysis. The systematic studies in simulated environments give a possibility to identify the contribution of different degradation mechanisms to the final failure. Here we describe the role of water vapour and thermal transients on microstructural changes and degradation of mechanical properties of two different SiC-based filters and also try to give a model for systematic approach for life-time prediction and for further development of such filter materials.

The effect of high temperature water vapour on the microstructure of two advanced commercially available SiC-based silicate-bonded hot gas filters was characterised with scanning electron microscope, a quantitative X-ray diffraction (XRD) method, Archimedes' method and by chemical analysis. Crystallization of an amorphous binder and oxidation of SiC were found but the rate of oxidation was low (Fig. 1). The exposed specimens were compared to the unexposed specimens[1]. There was a clear difference in the resistance to crystallization and oxidation of the two materials and they showed different trends of apparent density as function of time and the amount of water vapour. There were also differences in the change of mechanical properties of the two materials, but it was not possible to connect those directly to the found changes in the microstructure.

Preliminary two dimensional modelling has been used to model the response of the microstructure for mechanical and thermal strains of the real porous structure. In future even better models can be created with the help of developing 3-D imaging techniques. The resolution of the micro CT (computer tomography) is not yet good enough for details of the microstructure, but it can be improved by signal processing techniques.

In addition to the water vapour in the environment, other gaseous reactants, such as alkaline and sulphur vapours are often present in addition to the different ash components or condensing organic compounds in the environment. Alkalis can diffuse into glassy binder and degrease the creep resistance or they can also affect the crystallization behaviour of the glass[2]. Thermodynamic calculations can be used for modelling the stage, gaseous, molten and solid, of complex gas environment and to estimate the best temperature window for filtering.

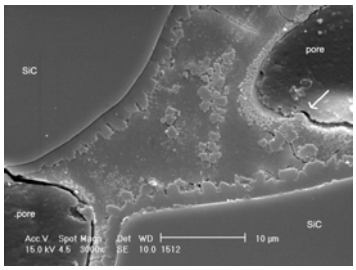
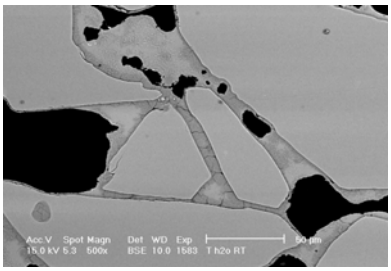



**Figure 1:** SEM image of the microstructure of silicate binder showing the oxidation of SiC at binder SiC interface and the crystallization of the binder at pore surface.



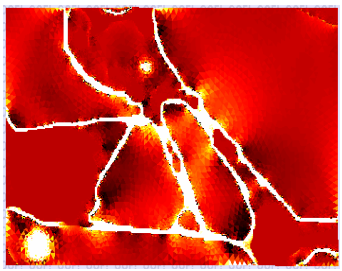


**Figure 2**: Example of the two dimensional modelling of the local stresses generated into the microstructure by mechanical and thermal strains.

1. P. Pastila, V.Helanti, A.-P. Nikkilä and T. Mäntylä, Advances in Applied Ceramics 105 (2005) 65
2. P. Pastila, V. Helanti, A.-P. Nikkilä and T. Mäntylä. J. Eur. Cer. Soc. 21(2001)1261