CHARACTERIZATION OF SILOXANE-INFILTRATED CERAMICS MICROSTRUCTURE BY SPECTRAL SCATTERING

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The spectral scattering technique (SST) is considered to estimate the scatterers (pores) size distribution (PSD). It is based on the fitting of spectral scattering coefficients determined by Mie theory and radiative transfer inverse problem solution. Mie theory calculation relies on the far-field-single-scattering approximation. The previously proposed method [1] was improved for multiphase system analysis. General expressions for multiphase systems were simplified to three-phase ones to reduce the number of optimization variables and adapted to the evaluation semitransparent ceramics infiltrated by the polymer.

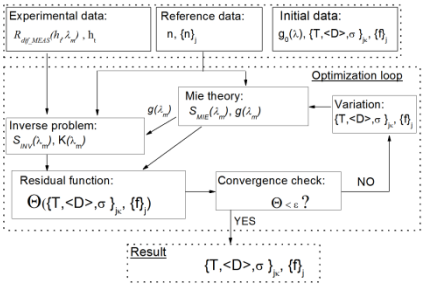

Fig.1. Spectral scattering technique principal scheme.

The SST scheme is shown in fig.1 with the following notation: $R_{diff\ MEAS}$ is directional – hemispherical reflectivity; h_t, are the arrays of thicknesses and wavelengths respectively; g is the mean scattering cosine; S and S_{MIE} are the spectral scattering coefficients determined by radiative transfer inverse problem solution and Mie theory respectively; $f, f_j, \{T, \langle D \rangle, \sigma\}_k$ is the set of parameters which define the discrete PSD function f_{ij}; Θ is the discrepancy function determined by the following equation: $\sqrt{\Sigma}$, where is the total number of wavelength discretes.

The SST was utilized for PSD determination in silica ceramics before and after infiltration by the methyl-phenyl-spyrocyclosiloxane. Size distribution of the pores filled with the polymer and with the air was estimated and compared to the results of mercury porometry. The PSD is shown to be affected by the infiltration procedure ("M" and "L-1/2" in fig.2) and polymerization regime ("L-1" and "L-2" in fig.2).

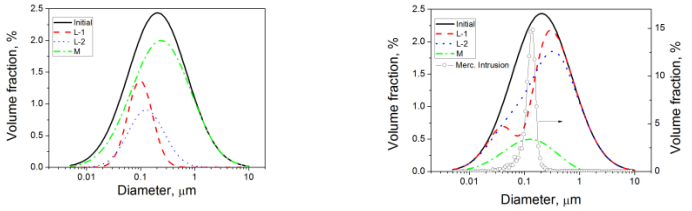

Fig.2. Scatterers (pore) size distribution of ceramics before and after the infiltration for pores filled with polymer (left) and the air (right); initial ceramics (Initial) and infiltrated by the melt (M) and by the polymer acetone solution, followed by the rapid (L-1) and by the slow (L-2) polymerization.

In conclusion, SST appeared to be a useful tool for microstructure analysis of polymer-infiltrated ceramics. It is non-destructive, affords closed pores to be analyzed and does not need specialized single purpose device.

[1] R.A.Mironov et.al. Optics and Spectroscopy, 124 (2018), P.289-297.

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