Infrared Micro-Reflectance Measurements and Modeling of Silicate Nanopowders

Mireia Sainz-Menchón[1, S, C], Iñigo González de Arrieta[1], Abdelali Zaki[2], Franck Fayon[3] and Gabriel A. López[1]

[1]*Physics, University of the Basque Country UPV/EHU, Leioa, Spain*
[2]*CNRS, Gif-sur-Yvette, France*
[3]*CEMHTI UPR3079, CNRS, Orléans, France*
mireia.sainz@ehu.eus

Traditionally, infrared spectroscopy has been used in the field of nanomaterials for qualitative analysis, such as the identification of surface species. However, in recent years, several spectroscopic studies have focused on acquiring quantitative dielectric and vibrational information, bringing to light new methods and applications. In the case of bulk glasses, there is a clear relationship between their structure and the optical properties, such as emissivity and reflectivity. However, when studying nanoglasses, the evaluation of the dielectric function must assess effects such as porosity through so-called effective medium theories.

In this work, a method for extracting the dielectric function of nanoglasses and obtaining quantitative structural information is presented. Due to its chemical and structural simplicity, colloidal silica was investigated using mid-infrared micro-reflectance spectroscopy. The use of this technique allows for greater accuracy and reproducibility between samples. The dielectric function of nanosilica has been extracted applying the Landau-Lifshitz-Looyenga effective medium approximation, and the results have been analyzed through a robust deconvolution procedure for the absorption bands, in which each component is attributed to a microscopic origin. Excellent agreement is found between our results and those obtained by the standard technique in glass studies (NMR). Because of the generality of our approach, it could be easily extended to other silicates.

This approach is the first step toward a better understanding of the relationship between the microstructure of heterogeneous materials and their optical properties, which could be the basis for precise modeling and quantifying the radiative response of heterogeneous ceramics at high temperature.