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APPLICATION OF RAMAN SPECTROSCOPY FOR ANALYZING LOCAL PHASE AND STRUCTURAL TRANSFORMATIONS IN CERAMICS

The study of the structural and phase features of various materials is an important task in materials science research. One of the most widespread methods for establishing the phase and structural properties of materials is X-ray diffraction (XRD). Although this method is commonly used in laboratories worldwide, Raman spectroscopy, which can address similar issues, offers several advantages. The application of Raman spectroscopy does not require complex sample preparation or time-consuming adjustment of the measurement equipment, yet valuable experimental data can be obtained in a few minutes. Due to its inherent features, Raman spectroscopy can also serve as a complementary technique that provides information about a sample that is not available using X-ray diffraction.
An essential difference between Raman spectroscopy and X-ray diffraction is its locality. In Raman spectroscopy, the properties of the near-surface layer of the sample are studied to a greater extent since the visible laser radiation passes only a few micrometers into the material, while in the method of X-ray diffraction, diffractograms are averaged from a larger material volume. In this report, a study of radiation defects in ceramics when irradiated with high-energy ions will be demonstrated. Since the thickness of the affected layer is typically ~ 1-10 μm, it is possible to follow the phase transformations and the resulting stresses in the material in more detail than using the X-ray diffraction method. It is also worth noting that the lateral localization of Raman spectroscopy provides an opportunity to study individual micro-objects, such as particles, grains, defects, or inclusions in ceramics. Our research group studied indentation marks obtained using a microhardness tester on AlN-based ceramics to monitor the effect of the stresses generated in the ceramics on the resulting Raman spectra.
Another advantage of Raman spectroscopy is its superior ability to distinguish polymorphic modifications of materials. Differentiating the cubic phase from the tetragonal phase is a common problem that arises when studying doped ZrO2. The X-ray diffraction method is not useful for this task because the positions of the reflections of these phases on the diffractograms are too close to be resolved, whereas the Raman spectra of the tetragonal and cubic phases of ZrO2 differ significantly. In our work, Raman spectroscopy was applied to specify the phase composition of ZrO2-based ceramics doped with different concentrations of CeO2.

Section

Energy and materials science (Section 2)

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