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MECHANICAL STRESSES IN SILICON NITRIDE AND ALUMINA NITRIDE CERAMICS IRRADIATED WITH HIGH ENERGY IONS*

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Irradiation with heavy ions of 1-3 MeV/nucleon energies is characterized by pronounced inhomogeneous ionization and nuclear stopping profiles. As a result, the level of energy losses varies over a very wide range, which in own turn leads to a inhomogeneous spatial distribution of radiation damage and associated mechanical stresses. The range of ions with the above energies, depending on the density of the material, does not exceed several tens of microns. For energies of ~ 1 MeV/nucleon, which are of the greatest interest from a practical point of view for simulation of the fission fragments impact, this value is in the range from several microns to ~ 10 microns. Therefore, to get reliable information about stress profiles, it is necessary to use experimental methods with a spatial resolution of ~ 1 micron. Such accuracy can be achieved in techniques based on the use of the piezospectroscopic effect), which connect the spectral shift in optical absorption, luminescence, or Raman scattering spectra with the level of mechanical stresses [1,2].

In this work depth-resolved Raman spectroscopy technique was used to study the residual stress profiles in polycrystalline silicon and aluminum nitrides irradiated with Xe (167 MeV, 1×10^{11} cm^{-2} ÷ 4.87×10^{13} cm^{-2}) and Bi (710 MeV, 1×10^{11} cm^{-2} ÷ 1×10^{13} cm^{-2}) ions. It was shown that both compressive and tensile stress fields are formed in the irradiated specimen, separated by a buffer zone located at a depth coinciding with the thickness of layer, amorphized due to multiple overlapping of the track regions. Compressive stresses are registered in subsurface region, while at a greater depth, the tensile stresses are recorded and their level of reaches the maximum value in the end of ion range. The size of the amorphous layer was evaluated from the dose dependence of the FWHM of the dominant 204 cm^{-1} line in Raman spectra and scanning electron microscopy. In contrast to Si_3N_4, radiation-stimulated changes in mechanical stresses in AlN were within the measurement error throughout the entire thickness of the irradiated layer, except of the near-surface region. The observed effect is associated with the different structural sensitivity of silicon and aluminum nitrides to high-density ionization - the formation of amorphous latent tracks in Si_3N_4 and their absence in AlN.

REFERENCES

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