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Ion beam induced phase transformation and krypton bubble formation in monoclinic zirconium oxide

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Abstract

Low energy krypton ion beam induced phase transformation and bubble formation in monoclinic zirconia (ZrO_2) has been studied using electron microscopy, Raman scattering, grazing incidence X-ray diffraction and photoluminescence spectroscopy. The zirconia samples were synthesized by the thermal decomposition method and 60 keV Kr^+ ion irradiation was carried out at 300 K and 143 K. The as-sintered ZrO_2 particles were found to be monoclinic in structure, however, upon 60 keV Kr^+ ion irradiation, a fraction of the sample (~4.9% (300 K) and ~8.3% (143 K) for the ion fluence of 1×10^{17}ions/cm^2) was transformed from monoclinic to tetragonal phase along with the formation of krypton bubbles. The size of the bubbles is found to increase with the ion fluence, irrespective of the sample temperature during ion irradiation. The phase transformation from monoclinic to tetragonal structure was mainly due to radiation damage process where the driving force is strain field associated with the O-vacancies. The monoclinic to tetragonal transformation rate is faster when the ion irradiation was carried out at 143 K and this is attributed to the immobility of defects and production of large number of oxygen vacancies. The krypton bubble formation might be hindering the monoclinic to tetragonal phase transformation rate.

Keywords: ion implantation, phase transformation, inert gas bubble, radiation damage

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