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TEM OBSERVATION of ROOM TEMPERATURE STABILITY AND PHASE TRANSFORMATION OF SHI INDUCED TETRAGONAL TRACKS IN MONOCLINIC ZIRCONIA

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Abstract (text submission) Pure bulk zirconia (ZrO_2) is a polymorphic oxide that exists in three different low pressure crystal structures below its melting point namely, the high temperature phases cubic and tetragonal as well as the low temperature monoclinic phase [1]. Irradiation of bulk natural zirconia at room temperature along the monoclinic [100]m crystal axis were shown by transmission electron microscopy to produce non-continuos tetragonal latent tracks consisting of segments approximately 30 nm in length and rectangular cross sections of the order 2.5 nm. The segments were aligned along the [001]t crystal axis and approximately 9° to the [100]m axis[2]. It was suggested that the mechanism for the stabilisation of the high temperature phase could be due to the surface energy of the interface surfaces, which will determine the critical crystallite size for RT stabilization [3], or the presence of additional vacancies and interstitial oxygen atoms [4]. In this presentation we present results for irradiated bulk monoclinic zirconia to determine the influence of interfacial surfaces and hence critical size on the formation and stabilization of latent tracks. Monoclinic ZrO_2 from the Palaborwa complex in South Africa was irradiated with 167 MeV Xe ions to a fluence of $2x10^{10}$ ions/cm^2 at the FLNR, JINR, Dubna. Plan view and cross sectional TEM lamellae were prepared by standard FIB lift out procedure using an FEI Helios NanoLab 650 and imaged in a JEOL ARM 200F TEM operating at 200 kV. Individual ion tracks were found to be composed of the high temperature stable tetragonal phase. The c axis of the monoclinic and tetragonal regions was parallel with 45° relative rotation about the c axis. Discontinuities in the tetragonal phase together with a slight misalignment relative to the ion path was ascribed to the difference in a-c angle between the tetragonal and monoclinic phase. Although stressed, the tetragonal inclusions were found to be stable at room temperature for at least several years although thermal excitation as well as excitation by high energy electrons was able to transform the tetragonal phase back into the monoclinic phase leaving behind a train of defect clusters as is typical of ion tracks in non-amorphisable crystals. References [1] J.E. Bailey, Proc. R. Soc. A. Math. Phys. Sci., 279 (1964) 395-412 [2] J.H. O'Connell, M.E Lee, V.A Skuratov and R.A. Rymzhanov, Nucl. Inst. Meth. Phys. Res. B, 473 (2020) 1-5 [3] M.W. Pitcher, S.V. Ushakov, A. Navrotsky, B.F. Woodfield, G. Li, J. Boerio-Coates and B.M. Tissue, J. Am. Ceram. Soc., 88 (2005) 160–167 [4] X. Lu, K. Liang, S. Gu, Y. Zheng and H.Fang, J. Mater. Sci., 32 (1997) 6653-6656

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