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LETTER

Ion irradiation of the TiO_2 polymorphs and cassiterite

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ABSTRACT

Thin crystals of rutile, brookite, anatase, and cassiterite were irradiated in situ in the transmission electron microscope using 1.0 MeV Kr ions at 50–300 K. Synthetic rutile and natural cassiterite, with 0.1–0.2 wt% impurities, remain crystalline up to a fluence of 5×10^{15} ions cm^{-2} without evidence for amorphization at 50 K. Natural brookite and anatase, with 0.3–0.5 wt% impurities, become amorphous at fluences of 8.1×10^{14} and 2.3×10^{14} ions cm^{-2}, respectively. We have also studied two natural rutile samples containing ~1.7 and 1.2 wt% impurities. These samples became amorphous at 9.2×10^{14} and 8.6×10^{14} ions cm^{-2} at 50 K, respectively. Further analyses of the fluence-temperature data for natural brookite, rutile, and anatase give critical amorphization temperatures of 168 ± 11, 209 ± 8, and 242 ± 6 K, respectively. Results are briefly discussed with respect to several criteria for radiation resistance, including aspects of the structure, bonding, and energetics of defect formation and migration.

Keywords: TiO_2 polymorphs, anatase, brookite, rutile, cassiterite, ion irradiation, defect migration