

Fig. 3 (color online) Raman spectra at different locations on the cross-sectional oxide films of 15-15Ti steel after exposure to CO_2 at $650\text{ }^\circ\text{C}$ for 50 h (numbers correspond to zones defined in Fig. 2).

Reference

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5 - 15 Surface Nanostructures and Formation Mechanism on TeO_2 Induced by Swift Heavy Ions under Grazing Incidence*

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Surface nanostructures (surface ion track) such as multiple nanodots or/and groove could be produced by single heavy ions (SHIs), when some materials are irradiated with SHIs under grazing incidence. The creation of equally spaced nanodots on the surface of the irradiated SrTiO_3 single crystal with grazing SHIs was previously explained as the periodic oscillation of electronic energy loss^[1]. Essentially, it was believed to be related to the periodicity of crystal structure. In the scenario proposed by Akcöltekin, *et al*^[1], a reasonable inference is that intermittent nanodots should not be expected on the surface of an amorphous material irradiated with grazing-incidence SHIs, because there is no long-range order in the amorphous material. However, it was observed clearly by atomic force microscopy (AFM) that the intermittent nanodots were formed on the surface of amorphous SiO_2/Si after grazing-angle heavy ion irradiation^[2]. Therefore, the formation mechanism remains still unclear.

In this work, single crystal samples of TeO_2 were irradiated with 1 569 MeV ^{86}Kr ions (10.1 keV/nm), 2 430 MeV ^{129}Xe ions (20.1 keV/nm) and 2 765 MeV ^{181}Ta ions (30.4 keV/nm), respectively, under grazing incidence conditions at Heavy Ion Research Facility in Lanzhou (HIRFL) in Institute of Modern Physics, Chinese Academy of Sciences. It was observed by using AFM that surface ion tracks could be formed for these three kinds of SHIs(Fig.1).

Along the ion incident direction, the surface ion track displays two distinct morphologies. In the first region, the groove is formed and typically bordered in both sides by a string of small nanodots. In contrast, as the incident ion penetrate deeper, the protrusions are formed. Interestingly, it was found that the feature of the protrusions is strongly dependent on the electronic energy loss. Combined with high-resolution transmission electron microscopy, we suggest that the formation mechanism of surface nanostructures on TeO_2 irradiated with SHIs under grazing incidence is attributed to Plateau-Rayleigh instability of nanofluid. More importantly, we propose that it also provides a unique experimental method, which could be used to validate the existing results of molecular dynamics simulation of the instability of nanofluids.

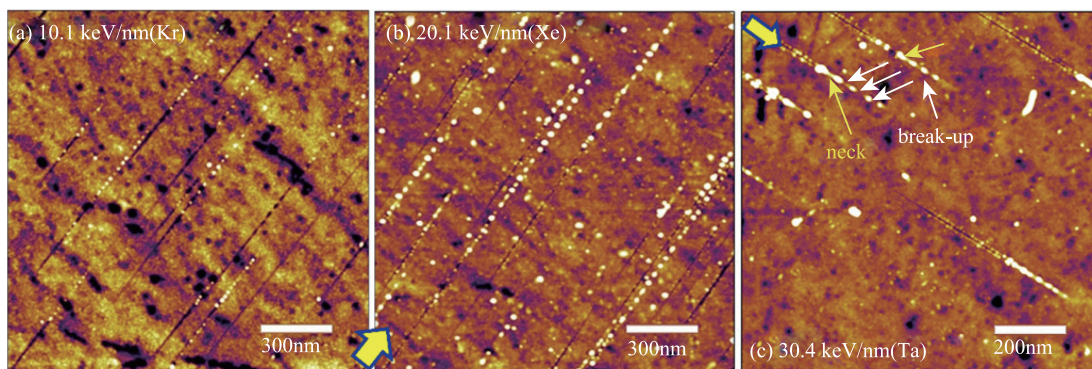


Fig. 1 (color online) AFM images of the irradiated TeO_2 by swift heavy ions under grazing (1°) incidence.

References

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5 - 16 The Reliabilities of HfO_2 -Based Ferroelectric Devices under Swift Heavy Ion Irradiation

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HfO_2 -based ferroelectric films are considered to be one of the key materials for the development of next generation microelectronic devices. Up to now, HfO_2 -based FeRAM devices show high immunity to proton and γ radiation^[1,2]. However, to our best knowledge, the effects of swift heavy ions (SHIs) on HfO_2 -based ferroelectric films were rarely reported and its mechanism is still missing. In this letter, we report the effect of SHI irradiation on the Zr-doped HfO_2 -based (HZO) capacitors. The devices were irradiated by 16 MeV/u ^{181}Ta ions with electronic energy loss $(dE/dx)_e$ of 49.3 keV/nm. The capacitance-voltage (C - V) and polarization-voltage (P - V) characteristics of the HfO_2 -based metal ferroelectric metal (MFM) capacitors were measured using Keithley Semiconductor Parameter Analyzer. As shown in Figs.1 and 2, we observed that the remanent polarization and relative permittivity of the capacitors decrease with increasing ion fluence, which is attributed to the enhanced pinning effects by the accumulation of defects and reduced orthorhombic phase fraction of the HfO_2 -based films. We found that the coercive field remains unchanged with the increase of ion fluence, which validated the screening effect can be ignored. This work provides the possible physical mechanisms of SHI irradiation on HfO_2 -based ferroelectrics, which is of significance for the space application of HfO_2 -based ferroelectric random access memory.