Tuning the conductivity of vanadium dioxide films on silicon by swift heavy ion irradiation

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AIP ADVANCES 1, 032168 (2011)

We demonstrate the generation of a persistent conductivity increase in vanadium dioxide thin films grown on single crystal silicon by irradiation with 1 GeV ^{238}U swift heavy ions at room temperature. VO_2 undergoes a temperature driven metalinsulator- transition (MIT) at 67 ˚C. After room temperature ion irradiation with high electronic energy loss of 50 keV/nm the conductivity of the films below the transition temperature is strongly increased proportional to the ion fluence of 5 10^9 U/cm^2 and 1 · 10^{10} U/cm^2. At high temperatures the conductivity decreases slightly. The ion irradiation slightly reduces the MIT temperature. This observed conductivity change is persistent and remains after heating the samples above the transition temperature and subsequent cooling. Low temperature measurements down to 15 K show no further MIT below room temperature. Although the conductivity increase after irradiation at such low fluences is due to single ion track effects, atomic force microscopy (AFM) measurements do not show surface hillocks, which are characteristic for ion tracks in other materials. Conductive AFM gives no evidence for conducting ion tracks but rather suggests the existence of conducting regions around poorly conducting ion tracks, possible due to stress generation. Another explanation of the persistent conductivity change could be the ion-induced modification of a high resistivity interface layer formed during film growth between the vanadium dioxide film and the n-Silicon substrate. The swift heavy ions may generate conducting filaments through this layer, thus increasing the effective contact area. Swift heavy ion irradiation can thus be used to tune the conductivity of VO_2 films on silicon substrates.