

Electronic properties of graphite-like ion tracks in insulating tetrahedral amorphous carbon

Nix AK, Schwen D, Ronning C, Krauser J, Trautmann C, Hofsäss H
REV. ADV. MATER. SCI. 15 (2007) 192-197

We investigated the formation of quasi one-dimensional conducting filaments in tetrahedral amorphous carbon (ta-C) films created by swift heavy ion irradiation. Various ta-C films with thicknesses of about 100 nm were grown using mass-separated ion beam deposition on highly conducting Si and Ni substrates. After deposition, the films were irradiated with 1 GeV ^{238}U ions at fluences between 10^9 and 10^{11} ions/cm². Due to their high electronic energy loss of about 40 keV/nm, the swift heavy ions graphitize the predominantly (70%) sp³-bound tetrahedral amorphous carbon film (ta-C) along their trajectories, yielding conducting nanowires embedded in an insulating matrix. Using atomic force microscopy (AFM) with conducting cantilevers and an applied bias voltage the presence of conducting tracks was confirmed and their conductivities were determined to be several orders of magnitude higher than that of the host matrix. Temperature-dependent electrical measurements were performed on the irradiated samples at 300 K - 15 K with fields of up to 5 V/ μm .