Studies of surface nanostructure formation due to swift heavy ion irradiation under grazing incidence

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Synopsis In this contribution we present new experimental results for swift heavy ion irradiation under grazing incidence. This particular collision geometry forces the track formation to a region close to the surface, sometimes visible as a chain of individual nanodots, whose length can be controlled by the angle of incidence. For irradiation of mica surfaces a new track form is observed.

Swift heavy ion (SHI) irradiation of solid targets can lead to permanent structural modifications in the bulk and at the surface (see e.g. [1-5] and refs. therein). In most studies the irradiation is performed under normal incidence with respect to the surface plane of the target. The impact of each individual projectile induces a long, straight nanometric track consisting of amorphous or otherwise modified target material. At the impact site of the ion usually a hillock- or crater-type nanostructure can be observed.

Performing SHI irradiation under grazing incidence offers new possibilities for the modification of surface and bulk properties on the nanometer scale. Due to this special collision geometry, the tracks are formed in a region close to the surface, sometimes visible as a chain of individual nanodots. The length of these chains can be controlled by the angle of incidence [2, 5]. So far, the formation of these chain-nanostructures have been observed for insulating materials like polymers, oxides and ionic crystals and their formation has been linked to a critical electronic energy loss dE/dx of the incident projectiles [2, 5].

By using high resolution atomic force microscopy, comparative studies of the chain formation for different materials, i.e. $SrTiO_3$, TiO_2, CaF_2 and mica, have been performed at the IRRSUD line at GANIL. These targets have been irradiated with Xe and Pb ions at kinetic energies between 90 and 100 MeV under very small grazing incidence angles between 0.2° and 2°. Imaged under AFM the track structures observed are strongly material dependent.

For mica, e.g. surprisingly "double tracks" seem to be formed which eventually combine to a single track (see. Fig. 1).

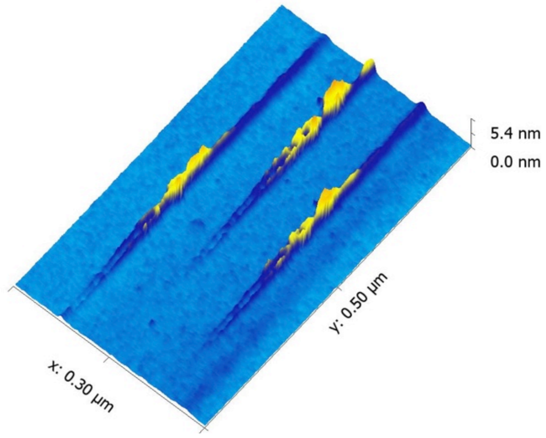

Figure 1. AFM image of surface tracks formed on a muskovit mica surface after 0.71 MeV/u $^{129}Xe^{23+}$ ion irradiation at 0.9°. The projectile is approaching the mica surface from the bottom-left opening first a groove, whose walls are visible as a "double track". After the projectile ion has entered deeper layers the double track is eventually combined into a single track.

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References

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