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Hillock formation on CaF₂, Al₂O₃, c-SiO₂ and MgO single crystal surfaces by ion impact - From potential energy deposition to electronic energy loss

Y. Y. Wang^{*,†1}, C. Grygiel[#], I. Monnet[#], E. Gruber^{*}, H. Lebius[#], B. Ban d'Etat[#],
J. R. Sun[†], Y. T. Zhao[†], Z. G. Wang[†], G. Q. Xiao[†], F. Aumayr^{*}

^{*} Institute of Applied Physics, TU Wien, 1040 Vienna, Austria

[†] Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China

[#] CIMAP-GANIL, CEA-CNRS-ENSICAEN-University of CAEN, F-14070 Caen, France

Synopsis For impact of very slow highly charged ions on single crystal surfaces the appearance of hillocks can be linked to a threshold in potential energy while for swift heavy ions a minimum electronic energy loss per unit length is necessary. Recent investigations on CaF₂ in the medium energy range bridge the gap between these two extreme cases. These investigations are now extended to other target materials.

Great interest has been drawn by the use of ions as possible tools for lithographic modifications or "nanostructuring" of surfaces. Investigations have shown that swift heavy ions (SHI) with kinetic energies in the MeV to GeV range can induce severe structural modifications at the surface [1] and in the bulk [2]. Individual slow highly charged ions (HCI) in the keV energy regime are also able to induce surface modifications on a nanometric scale [3]. These modifications result from the deposition of potential energy carried by HCI in the top-most surface layers or from electronic energy loss of SHI along its trajectory. In both cases several keV/nm³ are deposited within a few femtoseconds into the target's electronic system and subsequently transferred to the lattice atoms via electron-phonon coupling. This similarity between HCI and SHI was pointed out [3, 4] in order to establish a qualitative link between surface modifications by potential energy and electronic energy loss.

In the medium energy range (few MeV) hillock formation on single crystal surfaces induced by highly charged heavy ions has recently been studied. This study has shown an additive effect between depositions of kinetic energy and potential energy for surface nanostructure formation on CaF₂ [5].

We have now extended these investigations to other insulating materials including Al₂O₃, c-SiO₂ and MgO. As a first step we have irradiated these materials by 100 MeV Pb ions delivered by the IRRSUD beamline at GANIL. Because the electronic energy deposition depends on the SHI velocity [6], the impact en-

ergy of the SHI was varied by Al foil degradation.

The aim of these investigations is to find the S_e threshold for the SHI case. Unfortunately on several crystals the surface roughness or present surface contaminations prevented an unambiguous identification of ion-induced nanostructures. In these cases irradiation were also conducted under grazing angles of incidence. Surface tracks usually take the form of a chain of hillocks [7] and are therefore more easily identified than single ion-induced hillocks. Our results for SHI irradiation of Al₂O₃, c-SiO₂ and MgO will be presented at the conference.

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^{†1} E-mail: ywang@iap.tuwien.ac.at

