Applications at the RBI Dual Microprobe

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The Dual Microbeam end-station (DuMi), a unique setup where the MeV ion beams from the two accelerators are simultaneously focused to the μm scale, has been established at the RBI accelerator facility [1]. The setup uses in-house designed magnetic quadrupole triplet lens for focusing the ion beams provided by the 1.0 MV Tandetron accelerator, while a commercial electrostatic microprobe [2] is used for higher rigidity ions provided by the 6.0 MV Van de Graaff accelerator. The cylindrical DuMi chamber provides the possibility of several different working distances, including the short one (7 cm) with high demagnifications and 120 nm spatial resolution.

In this contribution, the authors focus on examples of applications carried out at the DuMi setup over the last year using one/two ion microbeams. The latter are based on a damaging / probing switching concept, where one microbeam is used to create changes in an irradiated sample, while the other one is used to in-situ detect these changes. Experiments carried out with one damaging beam and an in-situ probing beam in high current (RBS channeling) and low current (IBIC) will be presented.

References

[1] M. Jakšić and G. Provatas et al., The dual ion beam microprobe, Nucl. Instr. and Meth. B, 306 (2013) 25-28

[2] N.C. Podaru, F.L.van de Hoef, A.Gottdang, D.J.W.Mous, Design and performance of the HVE electrostatic nuclear microprobe, Nucl. Instr. and Meth. B, 306 (2013) 25-28

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Measurement of ion stopping power in the framework of nuclear reactions in plasmas

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The study of nuclear reactions and interactions in plasmas has recently assumed great importance because of its connection with processes such as laser-driven ion acceleration and nuclear fusion for massive energy production. In fact, the extremely high electron densities established in the plasma bring to different behaviour of charged particles with respect to that observed when a stable beam impinges on a solid target.

Ion stopping power in cold matter is relatively well known and has been characterized with the help of a large set of experimental data and theoretical studies (starting from the pioneering work conducted by Bethe in the early thirties [1, 2]); on the contrary a lot of open questions remain when it comes to ions stopping in a plasma, especially in the energy domain where the projectile ion velocity approaches that of free plasma electrons.

Theoretical and semiempirical simulations are thus essential to ensure appropriate experimental designs and interpretation of results. However, in the aforementioned energy domain there is a lack of experimental constraints, needed to tune-up the simulations; in particular, data reported in literature are few and in poor agreement with prediction of existing models.

The main aim of this work is a systematic and careful measurement of stopping power for several ions versus plasma parameters, especially in the region of thermal velocities, where the energy deposition should depend strongly on plasma temperature, density and ionization fraction.

The plasma will be generated under vacuum, by interaction of a laser beam with a solid target. Plasma plume will be characterized in temperature and density by optical and X-ray diagnostics; simultaneously the energy loss will be measured for an ion microbeam crossing the plume.

This contribution will provide an overview of the simulations performed with existing models and the results obtained during first tests for the characterization of experimental apparatus.

References

[1] H. Bethe, Annalen der Physik **397**, 325-400 (1930)
[2] H. Bethe, Annalen der Physik **76**, 293-299 (1932)

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Radiation response testing of structural materials for nuclear applications*

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Ion irradiation is widely used to simulate damage caused by neutron irradiation across a broad range of temperatures and fluences. Due to accelerated damage rates, it serves as an effective screening tool for the development and qualification of materials for irradiation environments. In the last decade, nanoindentation of ion-irradiated materials has gained significant interest as it allows for the assessment of irradiation-induced hardening even in thin irradiated layers. However, the effects of experimental parameters such as ion type, ion energy, and dose rate have not yet been fully explored.

In the present study, T91 ferritic/martensitic and oxide dispersion strengthened Fe-20Cr-5Al steels were exposed to ion irradiation using protons, helium, and heavy ions (primarily iron) with varying energies. Nanoindentation was employed to determine the nanomechanical properties of both reference and ion-irradiated samples. The effects of ion type and energy on the two selected materials are discussed.

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