Material science and nanostructures produced with GeV heavy ions

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The existing and future accelerator facilities at GSI and FAIR (an international Facility for Antiproton and Ion Research) provide unique opportunities for research with ion beams in many different disciplines [1]. The presentation gives a glimpse on the broad activities in the field of materials science and ion-track technology using swift heavy ions of GeV energy and above. The interest in such beams is based on the large energy deposition along the trajectory of each individual ion creating long nanoscopic trails of severe damage. In nanoscience, the small track size in combination with the large ion range (up to 100 µm and more) allows us to overcome limits of planar structuring techniques Several examples will be presented illustrating how to synthesize e.g. nanochannels and nanowires of tailored diameter, length, or shape with special electrical, optical, or thermal properties.

Ion beams at FAIR will permit materials science experiments with unprecedented ranges and intensities. Injecting for instance relativistic ions through a mm-thick diamond anvil of a high-pressure cell into a target under pressure, drives the local atomic structure far from equilibrium. Under such conditions, stabilization of new materials was evidenced via pathways in the phase diagram which are otherwise not accessible but of importance to simulate conditions existing in the Earth mantle. Testing materials behavior in extreme radiation, pressure, and temperature environments will also have a direct application to the understanding of structural materials degradation in next generation accelerator components, fusion and fission reactors, and shielding of equipment in deep space missions.

References

1. T. Stöhlker et al., Nucl. Instr. Meth. **365**, 680 (2015)