Nanoscale cascade dynamic effects and ion beam treatment of soft magnetic materials

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Classical radiation physics describes well several known phenomena (radiation embrittlement, swelling, radiation creep) based on relatively slow processes of thermo- and radiation-enhanced diffusion. Mechanisms based on the description of the defects migration processes cannot however, explain the small-dose effect under neutron and low-dose long-range effect under ion irradiation. In fact, in both cases we are talking about instant structural-phase rearrangements, at large distances with an insignificant number of displacements per atom (sometimes<0.001). The author and his colleagues found many arguments in favor of the decisive role of nanoscale dynamic effects in explaining the effect of cascade-forming radiation on matter. The presentation takes a brief look at the model considering the explosive energy release in the regions of the dense cascades of atomic displacements and the emission of powerful post-cascade solitary waves that initiate structural-phase transformations at their front in metastable media, theoretically, at unlimited distances (in practice at least up to several millimeters under ion irradiation, at $R_p < 1$ μM; Rp is the projected ion range). The application part of the report contains an overview of more than a dozen of articles of the author and his colleagues and the latest results on the effect of ion beams on the phase composition, atomic distribution, the grain and magnetic domain structure, as well as the magnetic properties of soft magnetic materials such as transformer steel (bands 0.1-0.35 mm thick), fine met (25 μM), perm alloy, and carbonyl iron powders. Mossbauer, X-ray diffraction, and TEM data are used.

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