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56 Years of Ion Tracks: Where Do We Stand?

Monday, 18 May 2015 18:00 (30 minutes)

After a brief historical and personal view on some highlights concerning ion tracks I will concentrate on the present state of understanding and modelling of track formation. The frequently used inelastic thermal spike model requires substantial modification with regard to two aspects. The first aspect concerns the assumption that the concentration of free carriers is independent of time and of the distance from the ion path. This assumption is only acceptable for metals but not for insulators and semiconductors. Several groups have now identified this deficiency and try to find solutions by following carrier production and subsequent processes in great detail. The progress made and the encountered difficulties will be outlined. The second aspect concerns the fact that the inelastic thermal spike model ignores thermal stresses. More precisely, the energy transferred from the electronic system to the atomic system appears not completely as heat as it is assumed in the inelastic thermal spike model, but is shared between heat and mechanical work (a generalization of the term $p\delta V$ in the first law of thermodynamics). The importance of this term for the energy balance will be demonstrated and the consequences with regard to melting and boiling will be discussed. It will turn out that, if the excitation in the track is sufficiently large, dislocation generation is much more probable than boiling. Experimental evidence for this process will be provided and its consequences for the radiation resistance of some non-amorphizable materials like NiO, MgO, and UO2 will be demonstrated.

Primary author: Dr KLAUMÜNZER, Siegfried (Helmholtz-Zentrum Berlin and GSI Darmstadt)

Presenter: Dr KLAUMÜNZER, Siegfried (Helmholtz-Zentrum Berlin and GSI Darmstadt)

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