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Energy Deposited by Secondary Electrons Generated by Swift Proton Beams through Polymethylmethacrylate

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Abstract : The ionization yield of ion tracks in polymers and bio-molecular systems reaches a maximum, known as the Bragg peak, close to the end of the ion trajectories. Along the path of the ions through the materials, many electrons are generated, which produce a cascade of further ionizations and, consequently, a shower of secondary electrons. Among these, very low energy secondary electrons can produce damage in the biomolecules by dissociative electron attachment. This work deals with the calculation of the energy distribution of electrons produced by protons in a sample of polymethylmethacrylate (PMMA), a material that is used as a phantom for living tissues in hadron therapy. PMMA is also of relevance for microelectronics in CMOS technologies and as a photoresist mask in electron beam lithography. We present a Monte Carlo code that, starting from a realistic description of the energy distribution of the electrons ejected by protons moving through PMMA, simulates the entire cascade of generated secondary electrons. By following in detail the motion of all these electrons, we find the radial distribution of the energy that they deposit in PMMA for several initial proton energies characteristic of the Bragg peak.

Keywords : Monte Carlo method, secondary electrons, energetic ions, ion-beam cancer therapy, ionization cross section, polymethylmethacrylate, proton beams, secondary electrons, radial energy distribution
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