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Study on Penetration of 4 MeV Electron Beam in Natural Rubber Latex

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Vulcanization with electron beam irradiation provides unique and high efficient processing for natural rubber latex. It is one of very interesting and effective industrial applications of particle accelerators. A 4-MeV RF linear accelerator and electron beam irradiation system have been developed for natural rubber vulcanization at the Plasma and Beam Physics Research Facility, Chiang Mai University. This accelerator will be able to produce electron beams with adjustable energy in a range of 0.7 to 4 MeV. The beams with different energies provide different doses and different distributions in the rubber latex. In this research, we used a Monte Carlo simulation program called GEANT4 to study transportation of 4-MeV electron beam with Gaussian transverse distribution through a vacuum window, an air gap and natural rubber latex. The vacuum window is made of 50-micron titanium foil and the natural rubber was placed 18 cm downstream the foil exit. Simulations of electron transverse and depth dose distribution in these materials were conducted. In addition, calculation on the irradiation throughput from this process was performed. The study results revealed that the 4-MeV electron beam with Gaussian distribution can penetrate uniformly about 0.8 cm in the natural rubber latex with the RMS transverse size of 1.4 mm at the rubber surface. The electron beam irradiation of about 0.02 second will provide the dose of around 50 kGy per irradiated point, which is enough for the rubber vulcanization process.

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