Solid phantom material for radiation theory electron-beam calibration

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In clinical dosimetry, the output of an electron beam is always specified in terms of absorbed dose in water rather than in tissue because water is homogeneous, constant in composition, and is readily available everywhere. However, a water phantom is not convenient to use in practice. There are problems like mechanical instability, the necessity for waterproofing of an ionization chamber, breakage and leakage of the container, etc. Furthermore, it is difficult to make depth-dose measurements with horizontal beams of low-energy electrons in a water phantom because the container wall then provides an appreciable part of the electron range. Solid phantom material is sometimes used as a water substitute, which eliminates all the problems water possesses (although it may substitute others). The dose to water is then calculated from the dose to the water substitute. The two most commonly used solid phantom materials in radiotherapy dosimetry are polystyrene and polymethylmethacrylate (PMMA).

For electron beam dosimetry, the absorption and scattering of electrons in a water substitute must be as close as possible to the values in water. Consideration must be given to the interaction processes characterized by the mass stopping power and angular scattering power. Neither polystyrene nor PMMA are ideal water-equivalent materials. Fluence correction factors are used in a common radiotherapy dosimetry protocol (TG-21, 1983) to account for dose discrepancies between water and the water substitutes in the d$\sb{\rm max}$ region, while scaling factors are used in the d$\sb{50}$ region for different materials.

The solid phantom material developed in the present research is based on an epoxy resin system originated by White (1974), which is composed of the epoxy resin, curing agent, filler and phenolic microspheres. Evaluation is done by Monte Carlo calculation and experimental measurements with an ionization chamber. Monte Carlo calculations show the absorbed dose curves and the energy spectral distributions. Experimental evaluations include transmission relative to water, relative ionization measurements and charge storage in the phantom material.