Purpose: To quantify the achievable accuracy in estimating photon radiological quantities in the 20-1000 keV range from idealized dual-energy CT measurements using a modified non-separable two-parameter cross section model.

Methods: The parametric fit model (PFM) [Med Phys 33:4115 2006] is modified based on method of Torikoshi et al [Phys Med Biol 48:673 2003], yielding a modified parametric fit model (mPFM) to describe attenuation coefficients by the sum of individual interaction cross-sections. Cross-sections are estimated as products of power functions of energy (E) and atomic number (Z), the Klein-Nishina cross section, and slowly varying tables of correction factors to account for residual errors, F(E,Z) and G(E,Z), correcting the photoelectric and scattering processes respectively. For mixtures and compounds, each pair of dual energy measurements yields a pair of non-separable nonlinear equations in two unknowns, effective atomic number ($Z^*$) and electron density ($\bar{n}_e$) that can be solved iteratively. For mixtures describing the range of biological tissue compositions, the accuracy of the mPFM was compared to a previously described [Med Phys 33:4115 2006] basis vector model (BVM).

Results: The mean percent absolute error for mPFM of linear attenuation coefficient, photoelectric interaction coefficient, and energy absorption coefficient of five mixtures and compounds are 0.03%-0.17%, 1.10%-6.03%, and 0.2%-1.19%, compared to 0.02%-0.15%, 0.44%-11.32%, and 0.11%-1.57% for BVM, compared 0.6%-2.2%, 10.8%-22.4% and 5%-10% for PFM over the 20-1000 keV range. mPFM reduces maximum errors to 0.15% compared to 4.49% for BVM for fluorine-based tissue.

Conclusions: mPFM improves accuracy of photon cross-section compared to PFM. BVM shows greater accuracy than mPFM for all tested tissue except for Teflon. mPFM also has the potential to extend DECT to computation of charged particle radiological quantities.
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