Appendix A. Estimation of inelastic electron beam – sample interaction

![Graph showing mass stopping power of Cu$_6$Sn$_5$ as a function of incident electron energy based on Bethe stopping power theory.]

**Figure A.1. Calculated mass stopping power of Cu$_6$Sn$_5$ as a function of incident electron energy based on Bethe stopping power theory.**

The energy loss upon interaction between the incident electron and the target atom can be expressed using Bethe stopping theory [28] as follows,

\[
\frac{dE}{dx} = -4\pi z^2 e^4 m v^2 \ln \left( \frac{m v^2}{N I} \right) - \beta^2
\]

where \( \frac{dE}{dx} \) is the energy lost in infinitesimal material thickness of \( dx \); \( z_e \) and \( Z_e \) are, respectively, the charge of the incident particle and the target atom; \( v = \beta c \) is the velocity of the incident particle, \( c \) is the speed of light, \( \gamma = \frac{1}{1 - \beta^2} \), \( N \) is the number density and \( I \) is the mean excitation energy of the target atoms, and \( m \) is the mass of the electron. The monoclinic and hexagonal structures of Cu$_6$Sn$_5$ density (\( \rho \)) are 8.3078 g/cm$^3$ and 8.4106 g/cm$^3$, respectively. For both monoclinic and hexagonal structures of Cu$_6$Sn$_5$, the mean excitation energy \( I = 435.1 \) eV. The stopping power values corresponding to 200 and 1,250kV TEM voltage are 1.749 and 1.258 MeV.cm$^2$.g$^{-1}$, respectively. This means the inelastic stopping power is about 0.5 times less in the case of ultrahigh-voltage compared to conventional low-voltage TEM.