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# The origin of defects induced in ultra-pure germanium by Electron Beam Deposition

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## Abstract

Vacuum with a hydrogen partial pressure of $10^{-9}$ mbar in combination with static shields was used to produce electron-beam deposited (EBD) Pt Schottky barrier diodes on n-type Ge with electrically active defect concentrations lower than $10^{11}$ cm$^{-3}$. Broad peaks observed in the deep level transient spectroscopy (DLTS) spectra of our diodes are indicative of surface defects while the sharp peaks that signal the presence of electron or hole traps were absent. Already in 1967, Chen et al [1] discussed a more efficient energy transfer mechanism by which an energetic electron, using a two-step process, transfers energy to the crystal lattice via a light atom (fig. 1). Energetic electrons reflected off the target as well as photons were not blocked by the shields indicating that collision products originating in the evaporator's 10 keV electron beam path with high enough energy to create vacancies were responsible for the observed EBD induced defects. This conclusion can also be drawn if n-Si is used [2].

Samples exposed to the conditions of EBD, without deposition (termed EB exposure) did not contain the same defects as the EBD samples except for the vacancy-antimony center (V-Sb), $H_{0.30}$. This implies that a necessary condition for the introduction of EBD defects was a thin metal layer through which energy was transferred to the germanium crystal lattice. The EB exposure defects have not yet been identified and are probably related to impurities that were accelerated into the germanium near-surface region before diffusing deeper into the material.

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## References

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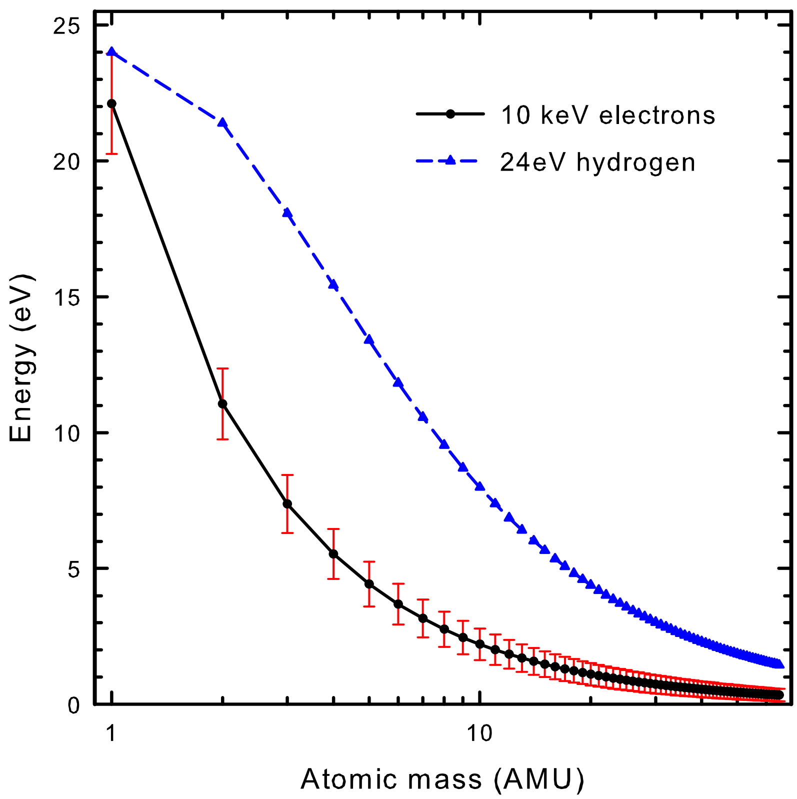


Figure 1: Maximum energy transferred during an elastic collision between a 10 keV electron or between a 24 eV hydrogen atom and particles of increasing mass. All momentum transfer calculations were performed non-relativistically where the bars denote the energy variation dependent on the relative velocity in a vacuum of the second particle.