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Experimental Evaluation of Possible Material Effects

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Recent BeEST experimental results displayed that the breadth of the measured peaks associated with electron capture (EC) decay were wider than the inherent resolution of the superconducting tunnel junction detector (STJ). One possible source of the measured peak resolution being appreciably worse than the resolution inherent in the STJ detector is from local imperfections in the materials that comprise the STJ. These could include clustering of the implanted species, crystal defects introduced during ion implantation, grain boundaries, or the presence of other impurities.
In this work six different samples were explored by atom probe tomography (APT): three implanted aluminum thin film samples and three implanted tantalum thin film samples. While clustering and grain boundary segregation were observed at higher doses, in the STJ devices these were not at concentrations that would affect the performance. The lack of detected Li clustering in the STJs and minimal amorphization at all doses suggest that the effect of the material environment on the spectral broadening from Li core-hole relaxation in these devices is minimal. The measured clustering data as a function of dose provides guidelines for implantation limits. These characterization techniques are broadly applicable beyond the BeEST experiment to other detector materials and implanted ions.

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