Radiation Generation with Pyroelectric Crystals

by

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ABSTRACT

Pyroelectric crystals heated or cooled in vacuum have been used to produce low-energy x-ray devices since 1992. In the course of this thesis, experiments with lithium tantalate ($LiTaO_3$) and lithium niobate ($LiNbO_3$) were performed to extend the usefulness of pyroelectric radiation sources. Paired-crystal x-ray generators were shown to double the x-ray energy and yield, and allow the k-shell fluorescence of any metal up to thorium (Z = 90). It was demonstrated that the electron emission from a single pyroelectric crystal could be transmitted through a beryllium window to allow the electron beam to be extracted from the vacuum chamber. The electron emission current and energy were measured, and a mathematical model was developed to predict emission current and energy. Magnetic deflection experiments were used to verify that the electric field produced by the pyroelectric effect in lithium tantalate was sufficient to ionize gas. Finally, a paired-crystal system was used to ionize a deuterium fill gas near a metallic tip mounted to a pyroelectric crystal, and accelerate these ions into a deuterated target mounted to the opposing crystal. This technique was used to produce a compact, low-power fusion neutron source driven by pyroelectric crystals.