Purpose: To assess the feasibility of a miniature pyroelectric electron and x-ray sources for brachytherapy applications.

Methods: Polarized z-cut lithium niobate crystals that initially measured 1 cm^3 were cut into various thicknesses. Samples were placed individually in a glass chamber held at 1x10^-3 Torr, and heat propagation measurements were taken on opposing z-axis crystal faces. For electron and x-ray measurements, crystals were mounted to a 200 micron thick 1 cm^2 substrate of high carbon steel. A 35º copper electron wedge target was placed 0.8 cm from the crystal face. The crystal substrate was heated with a Fluxeon Royer-based induction heater operating at 62 KHz. The liberated electron current was measured using a Keithley 614 electrometer. X-ray spectroscopy and count rate measurements were made using an Ortec 905-3 NaI(Tl) detector with an Ortec Trump-32 MCA and a PC based Geiger-Muller counter, respectively.

Results: Induction heating with a total device current of 212W produced an initial substrate heating of 2.3ºC per second from 23ºC to 125ºC with a maximum tempreture of 149ºC in 67 seconds during material testing. Linear heating of the 1 cm thick crystal on the face opposite the substrate was observed (0.182ºC/s rise) between 32ºC and 68ºC over the course of 240 seconds. Heating of 0.33 ºC/s was measured during device operation from 22ºC to 149ºC. Crystals of 1 cm thickness produced x-ray emissions with a maximum energy of 39 keV. Emission calculations indicate that 7.8x10^11 electrons were produced. This corresponds to an equivalent peak source activity of 0.6 mCi, assuming a 1% conversion of electrons to X-ray photons. During the heating period, an emission in packed bursts with a peak current of 4x10^-10A was measured.

Conclusions: Pyroelectric based emitters could potentially be used as miniature electron and x-ray sources for radiation therapy and imaging applications.

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No conflicts of interest are known for this research