

STUDY OF HIGH VOLTAGE CHARGE PUMPING WITH A RESONANT PIEZOELECTRIC DEVICE

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ABSTRACT

A crystal of lithium niobate was configured for use as a longitudinal-mode piezoelectric transformer (PT). High voltage gain was achieved by operating the system in a vacuum of less than 5×10^{-6} Torr and by driving the transformer at its fundamental and second harmonic modes. An electron gun was coupled to the transformer to allow for controlled release of charge to the high voltage terminal of the PT. An electron tube extracted a beam from a thermionic emission source and cylindrical optics focused the beam to a 2-mm spot at the PT output, which resulted in the production of x-rays via the bremsstrahlung interaction. Two diagnostic methods were used to measure the operation of the PT: x-ray spectroscopy and laser-optical interrogation. The x-ray diagnostic showed that the count rate and energy of the PT-generated x-rays was stable for greater than one hour of continuous operation. The laser-optical method was used to measure the interior mechanical stress, electric field, and developed voltage of along the length of the PT. A comparison between the fundamental and second harmonics showed no difference between maximum output voltage achieved by the PT. Both diagnostics showed that the PT is able to process up to $1.5 \mu\text{A}$ of current at 20-kV output in a continuous mode.