AbstractID: 13669 Title: A cold cathode X-ray source based on TiO2 nanotube field emission

Purpose: To assess the viability of titanium dioxide (TiO_2) nanotube arrays in field emission based x ray sources.

Methods and Materials: Aligned TiO_2 nanotube (NT) arrays with diameter and height in the range 30-100 nm and 1-10 μm, respectively, were grown by electrochemical oxidation from titanium (Ti) sheets in a glycerol+HF electrolyte. Anodization voltage was varied in the range 13-40 V to control TiO_2 NT parameters. As-grown amorphous TiO_2 NTs were annealed at 500^o C in air for 1 hour. Field emission properties were tested in a dynamic vacuum of $5x10^{-7}$ Torr and the current was measured as a function of applied electric field. The test setup utilizes a copper mesh grid spaced 400μm from a grounded NT array with a mesh density of 70%. A 2 mm diameter copper anode is spaced 10 mm from the grid and held at 60 kV potential for the production of X-rays, which pass through the stainless steel vacuum chamber via a borosilicate glass window. Radiographs of phantoms were produced using a charge integrating flat panel detector.

Results: From current-voltage characterization a clear Fowler-Nordheim (F-N) relationship relating applied NT array electric field and the resulting primary anode current and corresponding X-ray flux is observed. Initial results show that with an applied electric field of 4.5 V/μm, a stable 1.5 mA/cm^2 field effect current density is generated with 80 nm diameter NTs, providing sufficient flux for radiography. This configuration produces a minimum measured horizontal resolution of 3.1 line pairs (lp)/mm.

Conclusions: The results show that aligned TiO_2 NTs can be used as a field effect emission cold cathode to produce x ray emission.