Nanostructured Photoelectron Sources for Electron Beamlet Array Generation

We discuss herein, the nanofabrication of photocathodes consisting of Si and Au nanostructure arrays operating in the multiphoton absorption regime. Electron emission is stimulated by grazing incidence femtosecond pulses from a Ti:Sapphire laser (λ = 800 nm). We have simulated the local electric field strength at the nanostructured cathodes via the finite element method (FEM) using COMSOL Multiphysics, and measured electron emission spectra from the nanostructures using a time of flight (TOF) spectrometer. Si nanostructure arrays with highly uniform sub-10 nm tip radii have been prepared via a combined optical lithography and diffusion limited oxidation technique. The fabrication process allows nanometer control over the dimensions of the electron emitter structures, and a 3-photon absorption process has been observed. Similarly, uniform arrays of Au nanopillars have been prepared via electron beam lithography. The Au nanopillar geometry and grazing incidence light source allows excitation of longitudinal surface plasmon modes in the Au nanostructures, thus enhancing the electric field at the nanopillar apices. A 5-6-photon absorption process has been identified in the Au nanopillar arrays.

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