Plasmon-Enhanced Resonant Photoemission Using Atomically Thick Dielectric Coatings*

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Photoemission from nano-emitters is crucial for many applications, such as compact radiation sources, particle accelerators, ultrafast electron microscopy, carrier-envelope detection, and novel nano-electronic devices, for its high brightness, low emittance, extreme spatiotemporal resolution, and carrier-envelope sensitivity [1-2]. The quantum efficiency of photoemission from nanostructured emitters can be significantly improved due to the increase of the local optical fields from the geometrical field enhancement and surface plasmon resonances.

In this study, we propose to coat the metal nano-emitters with an atomically thick dielectric to further enhance the laser field near the nanotips. The full-wave optical simulation demonstrates an optical field enhancement factor of up to 400 [4], depending on the geometry of the nano-emitter and resonance wavelengths. The physics behind this lies in the secondary field enhancement of the plasmonic field in the coating layer beyond the geometrical plasmon field enhancement effects. A quantum photoemission model, which is constructed by solving the time-dependent Schrödinger equation exactly [2-4], is utilized to investigate the photoemission processes. It is found that, over a wide range of laser fields, the emission current density from the coated photoemitter is enhanced by at least 2 orders of magnitude as compared to the bare emitter (Fig. 1). The effects of the coating properties such as refractive index and thickness, and geometrical settings are studied, and tunable photoemission is numerically demonstrated using different lasers and emitter geometries. The current density from different geometrical nanopyramid emitters (corresponding to different resonance wavelengths) shows that the optical field tunneling occurs at an ultralow incident laser field of 0.03 V/nm [4].

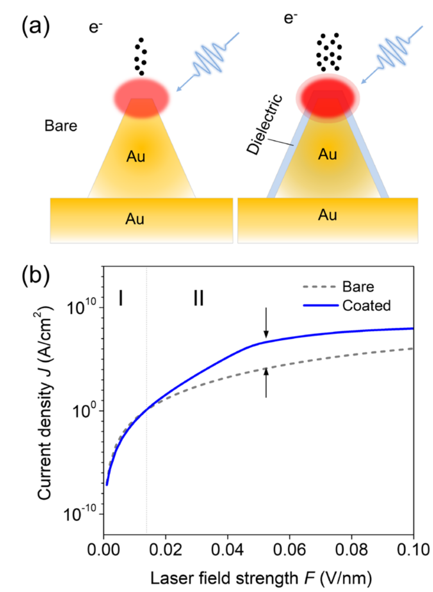

Figure 1 - (a) Schematic of the resonant photoemission from either bare or dielectric-coated Au-nanopyramid field emitters. (b) the photoemission current density J as a function of the laser field strength F, for the bare or coated photoemitters.

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