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Field emission of nanoprotusions, from its nucleation to quantum dot physics

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Metallic surfaces under an intense electric field tend to form nanoprotusions leading to very localized electron field emission and eventually a current runaway and the destruction of the emitter. The sharply pointed geometry of the protrusions strongly enhances the applied field over the topmost atoms which then permits all of the field emission to often come from only few atoms. This mechanism is very general and has been extensively studied for example with W [1], Pt [2], tungsten carbide-coated W, HfC and ZrC emitters [3]. Independently of the chemical composition of the emitter and the residual gas molecule in the UHV environment, it has been shown that these nanoprotusions have a peculiar voltage dependence of the electron energy spectrum compared to standard metallic emitters and can also been considered as interesting electron sources [1].

Although these protusions can appear spontaneously, we will show that a controlled formation of nanoscale protrusions on the top of macroscopic tips can be obtained by the field-surface-melting mechanism in UHV environment [1,4]. Then, we will present experimental conditions where nanoprotusions can be considered as promising collimated, coherent and stable electron emitters [2]. These properties are made possible because nanoprotusions tend to form quantum dots with discrete electronic energy levels giving rise to resonant tunneling or Coulomb blockade phenomena [5]. Finally, our recent results concerning the illumination of nanoprotusions with an intense femtosecond laser will highlight the stability of their physical properties at higher energy and ultra-low time scale [4].

References :

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Topic

Field Emission

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