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Electrically-driven optical antennas for novel light emission processes

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Gaps formed between metal surfaces control the coupling of localized plasmons, thus allowing gap-tuning targeted to exploit the enhanced optical fields for different applications. Classical electrodynamics fails to describe this coupling across sub-nm gaps, where quantum effects become important owing to non-local screening and spill-out of electrons. The advantages of narrow gap antennas have mostly been demonstrated for processes like SERS that are excited optically, but promising new phenomena appear when such antennas are fed by electric generators. However, the extreme difficulty of engineering and probing an electrically driven optical nanogap antenna has limited experimental investigations of physical concepts at stake in these conditions. The feasibility of structuring electron-fed antennas as nano-light sources has been recently demonstrated; however, this configuration remains very limited: too much power was lost as heat when operating the optical antenna, and the antenna operation time was limited by the structure lifetime to sustain a bias voltage for a few hours. The innovative structure that we suggest here will cope with all these limitations: ALD dielectric materials substitute the air gap to improve the antenna stability; a quantum efficiency of 10-1 is targeted owing to a significantly efficient antenna (2 orders of magnitude higher field enhancement). The resulting source will operate at room temperature and have a tunable spectral response (ranging from visible frequencies to THz regime) defined by the antenna geometry and the applied bias. Also, this source will be compact, Si-compatible, and will not request specific emitting materials (e.g. III-V semi-conductors) to operate.

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