Combining photoluminescence and electroluminescence in small gap molecular junctions

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Small gaps between metallic nanostructures are a multidisciplinary platform hosting new phenomena at the interplay between nano-electronics, plasmonics and sensing, as such structures provide both large plasmonic field enhancements (nanocavities) to boost light matter interactions, while also allowing current to tunnel and interact with light and molecules. This is for example exploited to measure Raman scattering from single molecules, study novel ways of downsizing electronic circuits in molecular junctions or achieve small electrical light sources. In recent years this concept of small gaps has been pushed further to extreme values looking at few metallic atom displacements creating so called picocavities.

So far, the excitation of such small structures has been mostly either optical or electrical, with only few papers reporting the joint excitation by both electrons and photons, considering either high conductances [1] or (relatively) high voltages [2,3]. Here we report the joint electrico-optical excitation of a molecular junction containing AuNPs functionalized with BPDT molecules [4] in a intermediate conductance and voltage regime. We observe that the combined effect of electrical and optical excitation is more than the simple sum of the two, and will discuss about the possible origins of the combined enhancement.

[1] Longji Cui et al. Nano Letters 2021 21 (6), 2658-2665 DOI: 10.1021/acs.nanolett.1c00503

[2] Braun, Kai, et al. *Beilstein Journal of Nanotechnology* 6.1 (2015): 1100-1106.

[3] Xiao Wang et al. ACS Nano 2015 9 (8), 8176-8183 DOI: 10.1021/acsnano.5b02361

[4] Amirtharaj, Sakthi Priya, et al. "Light Emission and Conductance Fluctuations in Electrically Driven and Plasmonically Enhanced Molecular Junctions." arXiv preprint arXiv:2307.06876 (2023) (submitted)