To integrate plasmonics with nano-electronics, it is important to directly convert electrical signals into plasmonic signals. It is well-known that tunneling junctions can excite and detect plasmons without the need for external light sources and optical elements [1-3]. Although tunnel junctions are widely used in commercial devices, the mechanisms of outcoupling of light from the junctions remain elusive. During the talk I will discuss our recent progress in the development of (molecular) tunnel junctions and how we apply them as electrical excitation sources for plasmons [4-7]. A bottle neck for practical applications is the low plasmon excitation efficiencies. Here, we show that surface-roughness of the electrode materials, the thickness of electrodes, and the shape of the junctions, are all crucial factors that need to be optimized the to maximise the plasmon excitation efficiency by mediating spatial mode overlap and momentum matching [7]. The MIM-TJ cavity SPP mode (MIM-SPP) can outcouple to photons *via* scattering of MIM-SPP at the metal-dielectric interfaces, or SPPs at the metal-dielectric interfaces (bound-SPPs) by mode coupling through the electrodes or mode coupling at the MIM-TJ edges. We find that the majority of the emitted light originates from the interface roughness-induced scattering of the MIM-SPP mode and show that different interface modes can be turned “on” or “off” by changing the electrode thickness. Using both experiment and theory, we report MIM-SPP exaction and outcoupling efficiencies of 0.62% in Al-AlOx-Au MIM-TJs, three orders of magnitude higher than previously reported and approaching the 10% theoretical limit. These results demonstrate that tunnelling junctions are promising candidates for sub-diffraction nanoscale light sources, currently we are integrating the junctions with plasmonic waveguides and other optical components.

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