Exploring Light Absorption and Light Emission with Gold Microflakes

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Summary: Ultra-thin, monocrystalline gold microflakes open new opportunities for the study of light absorption and light emission processes. We report results on hot-carrier dynamics, photoelectrochemical conversion and photoluminescence emission in this unique system.

In the last decade, optical nanoantennas have revolutionized light manipulation and control at the nanoscale. In particular, by engineering material and morphology it has become possible to shape light absorption and emission. While light absorption was initially considered a purely detrimental process in plasmonic nanostructures, the discovery of hot carriers has sparked great interest, leading to novel light-energy conversion pathways.

Monocrystalline gold microflakes offer interesting possibility for the study of light absorption and emission processes, seamlessly going from bulk metals to plasmonic nanostructures. We recently developed an advanced synthesis method that breaks the proportionality between lateral size and thickness of the gold microflakes [1]. As a result, it becomes possible to obtain on-substrate growth of large area (>100 um) and ultra-thin (<30nm) gold monocrystalline films, uniquely bridging bottom-up and top-down nanofabrication processes. I will thus discuss the distinct features of hot carrier generation in these monocrystalline films as well as their performance in plasmonic photoelectrochemical devices. I will also show comparison with cm-scale plasmonic photoanodes for solar-driven redox cells [2]. Finally, I will report interesting experimental observations on photoluminescence emission from the flakes as well as theoretical analysis of these results.

References

[1] Kiani F., Tagliabue G. - High-Aspect Ratio Au Microflakes via Gap-Assisted Synthesis – Chemistry of Materials 34 (3), 1278-1288

[2] Ma J., Oh K., Tagliabue G. - Understanding Wavelength-Dependent Synergies between Morphology and Photonic Design in TiO2-Based Solar Powered Redox Cells – Journal of Physical Chemistry C 2022