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Conceptual design of a nano-leaf for artificial photosynthesis

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The increase of atmospheric CO_2 to levels, which threatens human existence forced mankind to immediately address the production of carbon-neutral, renewable and storable energy. In nature, plants and some bacteria convert CO_2 and $H2_O$ into sugars and O_2 via photosynthesis, and many research groups are exploring the prospect of performing photosynthesis artificially by means of stable, inorganic photocatalysts. To achieve the all desired active under visible light artificial leaf one needs to improve the following three aspects:

- Efficient visible light absorber
- Improve reduction catalyst (H_2, CH_4, CH_3OH production)
- Effective oxidation catalyst (O_2 evolution)

Plasmonic nano-structures of d10 metals are suggested to be the future of photo-voltaics and photo-catalysis under solar irradiation thanks to their large light absorption cross-section, versatility, and stability. We investigated the impact of continuous plasmon excitation at 532 nm on the density of states of gold nanoparticles, and found an increase of the unoccupied density of d states of gold nanoparticles at the Fermi level, consistent with the formation of electron-hole pairs. Some of those electrons have sufficient energy to overcome the Schottky barrier, and be injected into TiO_2 conduction band, which we confirmed using a synchrotron based transient broadband mid-infrared spectroscopy. The results confirm that d10 metals plasmonic structures can act as direct light sensitizers, and use to drive photo-catalysis processes and produce electricity.

Biography

Jacinto Sá (PhD-Physical-Chemistry) is the group leader of Nanoleaves and Heterogeneous Catalysis at Uppsala University and Modern Heterogeneous Catalysis (MohCa) at Institute of Physical-Chemistry, Polish Acdemy of Sciences. He (H-index 19, i10-index 35) has published more that 80 publications in peer-reviewed journals, edited 3 books, wrote 12 book chapters, has one commercial development, gave 30 oral presentation at international conferences (4 as invited speaker), presented more than 50 posters, 25 departmental seminars. He received several awards, most recently the Joseph Wang award (2015) for outstanding contributions to the field of nanoscience.

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