Formation of conducting polymer by plasmon induced photopolymerization

Marisa Hoffmann[1], Anja Maria Steiner[1], Charlene Ng[1], and Andreas Fery[1,2]

[1] *Leibniz-Institut für Polymerforschung Dresden e.V., Germany*
[2] *Department of Physical Chemistry of Polymeric Materials, TU Dresden, Germany*

The plasmonic properties of nanoparticles can be used to strongly enhance photoexcitation reactions of molecules at the surface of the nanoparticles. This opens new pathways for the fabrication of complex nanostructured materials. A special interest is in the combination of conducting polymers with metallic nanoparticles.
We investigate the mechanism of the formation of polypyrrole at the interface between single plasmonic gold nanoparticles and TiO_2 upon illumination (Fig. 1). We evaluate the dependencies of the oxidative polymerization and the properties of the resulting material on the plasmonic properties of the gold nanoparticles and the dopants for the polypyrrole by using UV-Vis-NIR spectroscopy, scanning electron microscopy (SEM) and photocurrent measurements. The results shine light into a field of research in which contradictory conceptions were made [1-3]. Our findings emphasize the importance of the light irradiation and the presence of n-type semiconductors like TiO_2.
In the next step, the knowledge of the plasmon induced photopolymerization can be transferred from single particle level to nanoparticle lines – leading to a promising and scalable bottom-up method for the fabrication of functional materials with a resolution of a few nanometers.

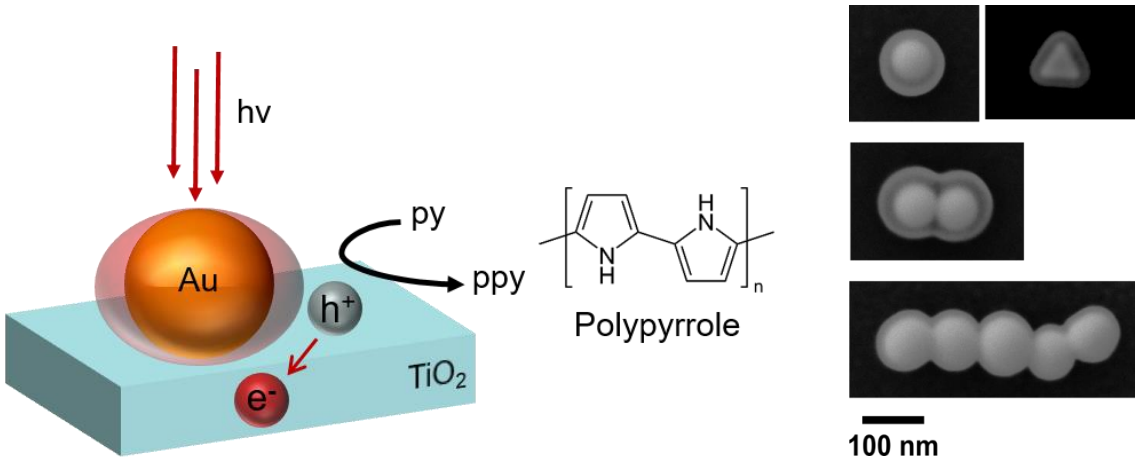

Figure 1. Schematic representation of the plasmon induced photopolymerization of pyrrole (left) and SEM images of obtained structures (right). The core-shell-structures of the gold nanoparticle and polymer are clearly visible.

[1] Y. Wang, T. Ding, *Optical Tuning of Plasmon-Enhanced Photoluminescence*. Nanoscale 2019. https://doi.org/10.1039/c9nr03725j.
[2] Y. Takahashi, et al., *Site-Selective Nanoscale-Polymerization of Pyrrole on Gold Nanoparticles via Plasmon Induced Charge Separation*. Nanoscale 2016, **8** (16), 8520–8524. https://doi.org/10.1039/c6nr01531j.
[3] H. Minamimoto et al., *Visualization of Active Sites for Plasmon-Induced Electron Transfer Reactions Using Photoelectrochemical Polymerization of Pyrrole*. J. Phys. Chem. C 2016, **120** (29), 16051–16058. https://doi.org/10.1021/acs.jpcc.5b12727.