Nanoplasmonics - Applications for Sensing and Solar cells

by

Prof. Bengt Kasemo

Chemical Physics Group,
Department of Applied Physics
Chalmers University of Technology
Gothenburg, Sweden
Email:kasemo@chalmers.se
http://www.chalmers.se/kemfys/

Localized surface plasmon resonances (LSPR) in metallic nanoparticles - also called Nanoplasmonics - are collective electron oscillations, in resonance with an external light field. The resulting effective EM field in the proximity of the nanoparticles, is much stronger than the external field and can be used for high sensitivity, real time sensing and for improvements of photon collection in solar cells.

For sensing we have developed a new, more general sensing scheme than normal LSPR, called Indirect Nanoplasmonic Sensing (INSP) [1-4], achieved by coating the sensing LSPR particles with a thin (order 10 nm) spacer layer, on top of which the material to be studied is deposited. Presented applications include dye impregnation of DSC solar cells [5], catalytic reactions like NOx storage/reduction [2], hydrogen uptake-storage–release [3], phase transitions/melting in polymers and metals [1], nano-calorimetry and corrosion [6]. The technique is robust and can be applied over a large T range, from cryo-temperatures to 1000 K and in gas and liquid phase.

The light scattering and the strongly enhanced EM field from LSPR excitations can also be used to improve solar cell performance. Several mechanisms can be used – far field effects and guided wave modes, local excitation enhancement (near-field effects) and potentially hot electron excitation. The principles are discussed and two examples taken from DSC [7] and amorphous Si solar cells [8] are presented.

[1] C. Langhammer, E. Larsson, B. Kasemo, *Nano Letters,* **10,** 3529 (2010)
[2] E. Larsson, C. Langhammer, I. Zoric and B. Kasemo, *Science*, **326**, 1091 (2009)
[3] Zoric´ Z., Larsson E M, Kasemo B, and Christoph Langhammer, Adv. Mater. **22**, 4628 (2010)
[4] *http://www.insplorion.com/technology/application-notes*
[5] Gusak, V ; Heiniger, LP; Zhdanov, VP; Grätzel, M; Kasemo, B; Langhammer, C, Energy & Environmental Science, **6**, 3627 (2013)
[6] Schwind, M; Hosseinpour, S; Langhammer C; Zoric I; Leygraf C; Kasemo B;
J. Electrochem. Soc. **160**, C487, (2013)
[7] Gusak, V; Kasemo, B; Hagglund, C, ACS Nano, **5**, 6218 (2011)
[8] Hagglund, C; Zach, M; Kasemo, Applied Physics Letters, **92**, 013113 (2008)