Electrochemical Photonics

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This talk will overview a new direction of research that can be conventionally called “electrochemical photonics”. It is based on voltage-controlled reversible selfassembly of plasmonic nanoparticle arrays at electrochemical liquid-liquid or solidliquid interfaces, the optical properties of which can dramatically vary with the applied voltage across the interface, also affected by the composition of nanoparticles, their size, and the array density. The effects to be discussed were first predicted by theory (M. Flatte, M. Urbakh, D. Sikdar, and A.A. Kornyshev), and, navigated by it, have been experimentally demonstrated by a team of researchers at Imperial College London (including Y. Ma, Yu. Montelongo, L. Velleman, M.P. Ceccini, et al, led by PIs: A.A. Kornyshev, J.B. Edel, and A.R. Kucernak); the effects refer to electro-switchable window-mirrors, tuneable colour mirrors, Fabry-Perot filters, as well as ultrasensitive Raman-scattering and reflectivity-based detectors of hazardous molecules or heavy metal ions, using these novel self-assembling and electrotuneable nanoplasmonic platforms. The physics and chemistry of this kind of meta-surfaces, tuneable within less than 1 V variation of electrode potential, have been reviewed in Refs.[1-3] and this talk will focus on few latest achievements. It will also highlight some interesting side result (D. Sikdar, J. Pendry, A.A. Kornyshev, 2020) that lay foundation for almost 100% extraction of light from Light Emitting Diodes.

[1] J.B. Edel, A.A. Kornyshev, and M. Urbakh, Self-Assembly of Nanoparticle Arrays for Use as Mirrors, Sensors, and Antennas, ACS Nano **7**, 9526-9632 (2013)

[2] J. Edel, A.A. Kornyshev, A. Kucernak, M. Urbakh, Fundamentals and applications of self-assembled plasmonic nanoparticles at interfaces, Chemical Soc. Reviews **45**, 1581-1596 (2016)

[3] J. B. Edel, Y. Ma and A. A. Kornyshev, Electrochemical photonics: a pathway towards electrovariable optical metamaterials, Nanophotonics (2023) - https://doi.org/10.1515/nanoph-2023-0053