Hydrogen Bonded Organic Pigment Colloidal Nanocrystals

Wolfgang Heiss[a]

[a]*Institute - Materials for Electronics and Energy Technology (i-MEET), Department Werkstoffwissenschaften, Friedrich-Alexander-Universität Erlangen-Nürnberg, Energie Campus Nürnberg (EnCN), Nürnberg, Germany*

Hydrogen-bonded organic pigments are omnipresent in human environments due to many applications of them for coloration purposes. While color fastness, long time durability, low costs and environmental friendliness are general properties of organic pigments, here we use them as a starting material for the synthesis of surface functionalized colloidal nanocrystals. Even though conventional hydrogen bonded organic pigments are non-luminescent, nanocrystals based on them emit light in colors spanning over the visible spectral region [1]. Nanocrystals from archetypical organic pigments such as quinacridone or phthalocyanine exhibit in addition promising electronic properties: we demonstrated photoconductors by painting the colloidal solutions on paper substrates with pre-structured electrodes. High responsivity was observed after selection of functional ligands, which were based on vitamin B6. These first attempts to achieve organic pigment nanocrystals were based on a hot-injection method, representing a modified route to what is commonly applied to various semiconductor colloidal quantum dots. Modifications of this first approach provided a series of hierarchical quinacridone micro-nanostructures, with well controlled nature-inspired shapes. Hedgehogs shaped and nano-dagger shaped nano-architectures appeared to exhibit geometrical similarities to living cells (Fig. 1a), and therefore were tested as cell culture scaffolds for human embryonic kidney (HEK) cells and rat basophilic leukemia (RBL) cells. The organic pigment scaffolds allowed to photo-stimulate single cells in a highly local fashion (Fig. 1b). In the cells we found reversible conductance changes in ion-selective, voltage- or temperature-gated channels (Fig. 1c.) To the best of our knowledge these are the first measurements of semiconductor-mediated photomodulation of specific ion channel behavior. This shows, that organic pigment particles usually used for painting, can be transferred into bio-opto-electronic components, hardly achievable with any other materials.

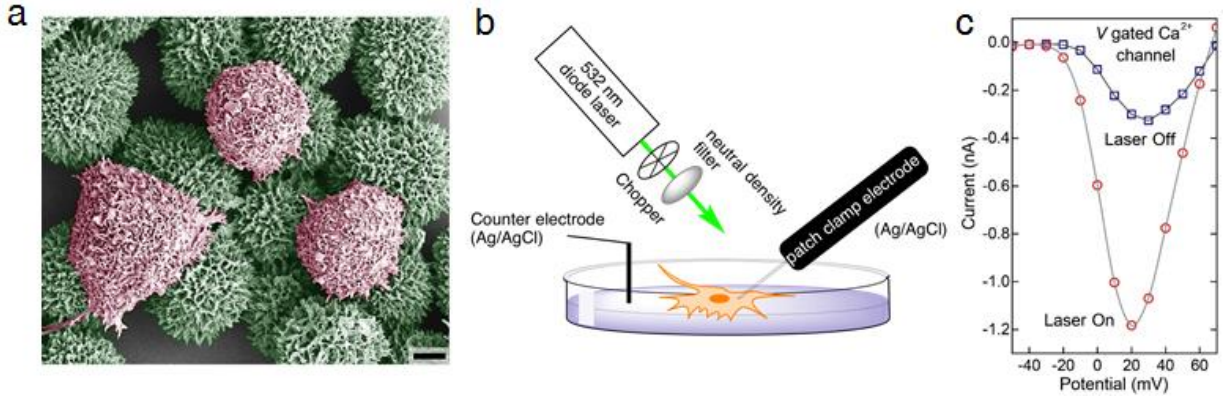

Fig. 1 (a) Rat basophilic leukemia cells (pink) grown on top of a layer of hierarchical quinacridone micro-nanostructures (green, scale bar is 2 μm). (b) Experimental setup to photostimulate conductance changes through ion channels of single cells. (c) Photomodulated current of Ca^{2+} ion channels.

1) Sytnyk, M. et al.; *J. Am. Chem. Soc*. **2014**, 136, 16522−16532