BIO-RELATED RESEARCH ON AND WITH NANOPARTICLES FROM TU DRESDEN

Alexander Eychmüller

TU Dresden, Physical Chemistry, Bergstrasse 66b, 01062 Dresden, Germany, EU,
alexander.eychmueller@chemie.tu-dresden.de

Abstract

Currently, we conduct synthetical efforts to prepare radiolabelled emitting semiconductor nanoparticles (NPs). Tracking of emissive NPs in biological and medical environments has been demonstrated by a number of groups on various routes. We, e.g., infiltrated lipid droplets with core-shell-NPs and with this were able to contribute qualitatively to answers to open questions in the context of lipid metabolisms [1]. The simultaneous labeling with radioactive material aims at a deeper understanding of the underlying bio-processes on a quantitative level. We will line out our thoughts regarding appropriate synthesis schemes with respect to minimizing the intake and handling of radioactive material as well as first results [2].

Since a few years, hydro- and aerogels based on semiconductor, metal and metaloxide NPs are accessible. Their superior properties are largely related to their light weight, open pore structure and large accessible inner surfaces [3]. The youngest member of this class of materials is a mixed ZnO/Pd aerogel (cf. Fig.1) which shows very good performance in the methanol steam reforming [4].

This is mentioned only to set the scene for another bio-related project we currently follow in which we study the co-assembly of semiconductor NPs and enzymes into functional architectures in the field of sensing. We fabricated enzyme encapsulated mercaptosuccinic acid capped CdTe hydrogels using the sol-gel method. The porous three dimensional NP hydrogel turned out to be an adequate encapsulation medium for enzymes acting both a bio-catalysis and a fluorescence signaling unit, and was taken as a multi-functional platform in the development of optical biosensors (cf. Fig.2) [5]. Both enzyme-encapsulating hydrogels and xerogels exhibited a good sensing ability to the example analyte. As a versatile enzyme entrapment matrix, the NP gels offer great potential in the development of various enzyme-based biosensors and portable sensing devices. Finally, I will report on our latest results in the development of bio-fuel cells based on the metal aerogel technology [6].

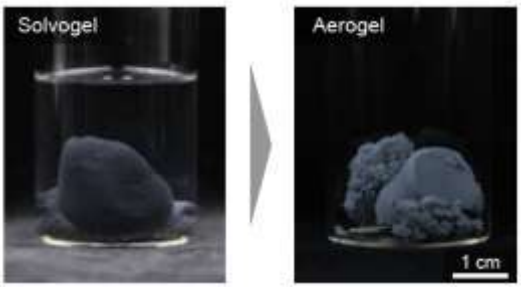

Fig.1 Pd-ZnO aerogel derived via a colloido-chemical route

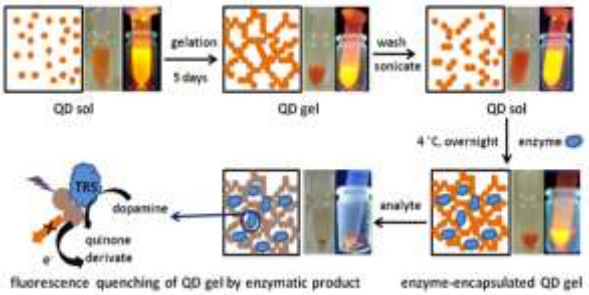

Fig.2 Sensor based on a hybrid nanoparticle-enzyme-gel approach

ACKNOWLEDGEMENTS

The author is indepted to the DFG for funding under DFG EY 10-1, 16-1 and 16-2, to the ERC for granting the AdG AEROCAT as well as to the Alexander von Humboldt foundation for fellowships granted to Dr. Wei Liu, Dr. Yipei Juan, Dr. Dan Wen and Dr. Chengzhou Zhu.

LITERATURE

[1] a) Bruns, O. T., Ittrich, H., Peldschus, K., Kaul, M. G., Tromsdorf, U. I., Lauterwasser, J., Nikolic, M. S., Mollwitz, B., Merkel, M., Bigall, N. C., Sapra, S., Reimer, R., Hohenberg, H., Weller, H., Eychmüller, A., Adam, G., Beisiegel, U., Heeren, J., *Nature Nanotechnology* **2009,** 4, 193, b) Bartelt, A., Bruns, O. T., Reimer, R., Hohenberg, H., Ittrich, H., Peldschus, K., Kaul, M. G., Tromsdorf, U. I., Weller, H., Waurisch, C., Eychmüller, A., Gordts, P. L. S.- M., Rinninger, F., Bruegelmann, K., Freund, B., Nielsen, P., Merkel, M., Heeren, J., *Nature Medicine*, **2011**, 17, 200, c) Carambia, A., Freund, B., Schwinge, D., Bruns, O. T., Salmen, N. C., Ittrich, H., Reimer, R., Heine, M., Huber1, S., Waurisch, C., Eychmüller, A., Wraith, D. C., Korn, T, Nielsen, P., Weller, H., Schramm, C., Lüth, S., Lohse, A. W., Heeren, J., Herkel, J., submitted.

[2] Stachowski, G., Waurisch, C., Hickey, S. G., Nielsen, P., Freund, B., Heeren, J., Eychmüller, A., submitted.

[3] a) Arachchige, I. A., Brock, S. L., *Acc. Chem. Res.*, **2007**, 40, 801, b) Gaponik, N., Herrmann, A.-K., Eychmüller, A., *J. Phys. Chem. Lett.*, **2012,** 3, 8, c) Bigall, N. C., Herrmann, A.-K., Vogel, M., Rose, M. Simon, P., Carrillo-Cabrera, W., Dorfs, D., Kaskel, S., Gaponik, N., Eychmüller, A., *Angew. Chem. Int. Ed.*, **2009,** 48, 9731, d) Liu, W., Herrmann, A.-K., Geiger, D., Borchardt, L., Simon, F., Kaskel, S., Gaponik, N., Eychmüller, A., *Angew. Chem. Int. Ed.,* **2012,** 51, 5743, e) Liu, W., Rodriguez, P., Borchardt, L., Foelske, A., Yuan, J., Herrmann, A.-K., Geiger, D., Zheng, Z., Kaskel, S., Gaponik, N., Kötz, R., Schmidt, T. J., Eychmüller, A., *Angew. Chem. Int. Ed.* **2013**, 52, 9849, f) A.-K. Herrmann, P. Formanek, L. Borchardt, M. Klose, L. Giebeler, J. Eckert, S. Kaskel, N. Gaponik, A. Eychmüller, *Chem. Mater.* **2014**, 26, 1074.

[4] Ziegler, C., Klosz, S., Borchardt, L., Kaskel, S., Friedrich, M., Keilhauer, T., Armbrüster, M., Eychmüller, A., submitted.

[5] a) Yuan, J., Gaponik, N., Eychmüller, A., *Anal. Chem.*, **2012,** 84, 5047, b) Yuan, J., Gaponik, N., Eychmüller, A., *Angew. Chemie Int. Ed*, **2013,** 125, 976.

[6] a) D. Wen, A.-K. Herrmann, L. Borchardt, F. Simon, W. Liu, S. Kaskel, A. Eychmüller, *J. Am. Chem. Soc.* **2014**, 136, 2727, b) D. Wen, W. Liu, A.-K. Herrmann, A. Eychmüller, *Chem. Eur. J.* **2014**, 20, 4380.