Materials chemistry of carbon nanotubes, single metal atoms and metal oxide thin films

Jörg J. Schneider*

Technische Universität Darmstadt, Eduard-Zintl-Institut für Anorganische und Physikalische Chemie, Peter-Grünberg-Str.12, 64287 Darmstadt, Germany
joerg.schneider@tu.darmstadt.de

We will present different selected facetes of our materials research work at the Inorganic Department at TU Darmstadt over the last decade or so.

- Vertically aligned carbon nanotubes (VACNT) are accessible via chemical vapor deposition method as up to millimeter long dense nanostructures. They exhibit high mechanical strength and a a superior electrical conductivity and can be structured in various shapes and sizes. These prerequisites qualify them as ideal micro-nanostructured materials with impact towards various technological developments. Some of them will be overviewed broadly to show their potential [1-3].
- Based on a combination of materials and organometallic chemistry we will show how soluble zerovalent iron and N doped VACNTs allow an access towards single atom catalysts for the oxygen reduction reaction.
- By using single source molecular precursors, we will present how a combination of those can allow access to mixed metal oxide thin films which are promising functional materials in electronics. A solution-based approach and a gas phase approach will be introduced which allow access to such materials [4-7].

[1] C. Nick, S. Yadav, R. Joshi, J.J. Schneider, C. Thielemann. A three-dimensional microelectrode array composed of vertically aligned ultra-dense carbon nanotube networks. Appl. Phys. Lett. (2015), 107, 01310.
[2] J.J. Schneider, Perspectives for biomimetically inspired mechanical sensing, bioactive surfaces and electrical cell interfacing using vertically aligned carbon nanotubes arrays. Adv. Biosys. (2017), 1, 1700101
[3] D.J. Babu, M. Mail, W. Barthlott, J.J. Schneider**.** Superhydrophobic vertically aligned carbon nanotubes for biomimetic air retention under water (Salvinia effect). Adv. Mater. Interf. (2017), 4, 1700273
[4] S. Sanctis, R. C. Hoffmann, R. Precht, W. Anwand, J. J. Schneider. Understanding metal oxide transistor characteristics of low temperature molecular precursor derived amorphous indium zinc oxide. J. Mater. Chem. C (2016), 4, 10935-10944
[5] N. Koswlowski, S. Sanctis, R. W. Hoffmann, M. Bruns, J. J. Schneider. A single source precursor route to dielectric amorphous aluminium oxide. Solution synthesis, oxide formation electrical properties and application in a field effect transistor device. J. Mater. Chem. C (2019), 7, 1048-1056
[6] I.M. Büschges, V. Trouillet, J.J. Schneider. Electronic influence of ultrathin aluminum-oxide on the transistor device performance of binary indium/tin oxide films. J. Mater. Chem. C (2022) 10, 5447–5454; DOI: 10.1039/D2TC00285J
[7] I.M. Büschges, V.Trouillet, A-C. Dippel, J.J. Schneider. MgO doped amorphous indium-zinc oxide thin films by thermally induced atomic layer deposition. Insights into structural and electronic properties". Adv. Mater. Interf. (2024), DOI: 10.1002/admi.202400758