IAP Seminar

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TU Wien, Institut für Angewandte Physik, E134
1040 Wien, Wiedner Hauptstraße 8-10
Yellow Tower „B“, 5th floor, SEM.R. DB gelb 05 B

Anodic TiO_2 nanotube layers: excellent platform for secondary materials

The self-organized 1D TiO_2 nanotubular layers have attracted considerable scientific and technological interest over the past 13 years, all motivated by an expected great performance in the range of applications including photo-catalysis, solar cells, hydrogen generation and biomedical uses.[1,2] The synthesis these nanotubular layers has been carried out by a conventional electrochemical anodization of Ti sheet that is very simple and a low-cost method. Except the 1D character, these nanotubes possess unique features such as tunable dimensionality, structural flexibility, unidirectional electron transport through nanotube walls, chemical and mechanical stability and biocompatibility.

One of the major application targets of TiO_2 nanotubes has been their utilization as scaffolds or templates for deposition of secondary materials towards new applications. Numerous techniques were utilized for this purpose, such as for example wet chemical and electrochemical routes or physical deposition techniques.[3] However, recently it has been shown that the utilization of Atomic Layer Deposition (ALD) can extend the functional range of TiO_2 nanotubes by homogenous coatings or decoration of tube interiors by a secondary materials.[3-12] ALD is the only technique of choice to coat in particular high-aspect ratio nanotube layers. Among the most important advantages of ALD ultrathin coatings of materials as TiO_2,[4] Al_2O_3,[5] ZnO,[6, 7] or CdS8 is that they annihilate electron traps at the TiO_2 nanotubular surface and thus increases the concentration of the photo-generated charge carriers. Overall, the deposited coatings influence strongly photo-electrochemical,[4-8] chemical, mechanical and structural[9] properties of nanotube layers. In addition, nanotube layers can be very homogenously decorated with noble metal particles[10,11] for various catalytic applications.

The presentation will focus in detail on the coating and decoration of the TiO_2 nanotube layer by various materials using ALD. Experimental details and some very recent photocatalytic,[4] sensing,[7] solar cell,[8] catalytic,[11] and battery[12] reports will be presented and discussed.

[1] J. M. Macak et al., Curr. Opin. Solid State Mater. Sci., 2007, 1-2 , 3-17.
[2] K. Lee, A. Mazare, P. Schmuki, Chem. Rev. , 2014 , 114 , 9385-9454.
[3] J. M. Macak, Chapter 3 in: D. Losic and A. Santos, Electrochemically Engineered Nanoporous Structures, Springer International Publishing, Switzerland, 2015 .
[4] H. Sopha et al., Appl. Mater. Today, 2017, 9 , 104-110.
[5] Q. Gui et al., ACS Appl. Mater. Interfaces, 2014 , 6 , 17053-17058.
[6] A. Ghobadi et al., Sci. Rep., 2016 , 6 , 30587.
[7] S. Ng et al., Adv. Eng. Mater ., DOI: 10.1002/adem.201700589
[8] M. Krbal et al., Nanoscale, 2017 , 9 , 7755-7759.
[9] R. Zazpe et al., Langmuir , 2017 , 33 , 3208-3216.
[10] L. Assaud, et al., ACS Appl. Mater. Interfaces, 2015 , 7 , 24533–24542.
[11] J. Yoo et al., Electrochem. Commun. , 2018 , 86 , 6-11.
[12] H. Sopha et al., ACS Omega , 2017 , 2 , 2749-275.

All interested colleagues are welcome to this seminar lecture (45 min. presentation followed by discussion)

Friedrich Aumayr
(LVA-Leiter)

Ulrike Diebold
(Seminar Chair)