

SCIENTIFIC AND METHOD MODULES

Module name	Quantum Coherent Structures Transparent Conductive Oxides – Fundamentals and Applications
Number	2017-A3
Aims	The material class of transparent conductive materials has been discovered 1907 by Karl W. Baedeker in Leipzig. This module focuses on modern transparent functional materials, from fabrication through material physics to applications.
Basics	covered in basic modules B1–B3, solid state physics, wide gap materials
Contents	The fundamental solid state aspects include defect formation in such materials (for few if any defects, a correlation between experimental physical defects properties and microscopic defect structure exist), the electronic band structure theory (LDA is not a good approximation for such metal oxides) and p-type doping (which is notoriously difficult for many oxides). Research on bulk properties has been promoted by the availability of substrates and/or bulk crystals for a number of oxides (ZnO for a while, recently Ga ₂ O ₃). From an application point of view, materials with larger mobility (at high carrier concentration), materials from earth abundant materials (avoiding expensive and noble metals), materials suitable for low temperature fabrication (in order to reduce the energy budget of industrial processes, process compatibility with flexible electronics), and amorphous materials (for flexible electronics and also room temperature deposition) are desirable.
Methods	Thin film deposition, optical and electrical characterization, device processing, however module has no focus on methodological aspects.
Type	Two-day block course
Date (month/year)	18 to 22 September 2017 (two days, 3, 4 or 5 days optional)
Time	See program: http://www.uni-leipzig.de/~hlp/TCO2017/program.html
Work load	15 hours presence/ 45 hours self-study
Examination	As module exam one of the invited talks has to be summarized with a few references and the discussion after the presentation reproduced. Typical length of this work (in English) is 2 pages. The paper will be graded.
Credit points	2
Responsible scientists	M. Grundmann
International guest lecturers	J. Driscoll (Cambridge University), G. Hautier (Univ. Cath. de Louvain), K.D. Leedy (WP-AFB, Dayton, OH), Ch. McConville (RMIT Univ., Melbourne), M. Olmstead (U Washington, Seattle), T. Omata (Tohoku University), J. B. Varley (Lawrence Livermore), G. Villora (NIMS, Tsukuba), L. Vines (University of Oslo), J. Zúñiga-Pérez (CRHEA, Valbonne)
Industrial partners	PANalytical
Recommendations for literature, e-learning	Transparent Electronics: From Synthesis to Applications, Editor: ANTONIO FACCHETTI and TOBIN J. MARKS, John Wiley & Sons Ltd, 2010; Handbook of Transparent Conductors, Editor: David S. Ginley, Hideo Hosono, David C. Paine, Springer Science and Business Media, 2010; Transparent Electronics, Autor: J.F. Wager, D.A. Keszler, R.E. Presley, Springer Verlag, 2008; Springer Series in Materials Science 104, Transparent Conductive Zinc Oxide, Basics and Applications in Thin Film Solar Cells, Editor: Klaus Ellmer, Andreas Klein, Bernd Rech, Springer Verlag 2008