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S E M I N A R
aus
Halbleiterphysik und Nanotechnologie

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"X-ray absorption spectroscopy for element selective investigations of structure, valence and magnetism in doped oxides"

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The use of x-ray absorption spectroscopy (XAS) and in particular x-ray linear dichroism (XLD) and x-ray magnetic circular dichroism (XMCD) offers the possibility to study a range of physical properties with element specificity. The combination of XAS at the near edge (XANES) and XLD allows determining the valence state as well as the local structural environment of dopant atoms, cationic and anionic sublattice in doped oxides. In addition XMCD allows to investigate the magnetic properties with element and valence selectivity. For the Co-doped ZnO system a comprehensive set of quality indicators based on XAS could be established which assure that Co substitutes for Zn and the formation of metallic Co precipitations can be ruled out [1]. Here the benefits of the XAS-based approach will be illustrated by several examples. It is demonstrated how XANES allows to determine the valence of the Co dopant as a function of the preparation conditions of Co-doped ZnO (Co:ZnO) [2] or accross the transition from Co:ZnO to the $ZnCo_2O_4$ spinel [3], and at the same time XLD evidences the evolution of the local structural properties [2,3]. High field XMCD reveals that the magnetic interaction remains antiferromagnetic irrespective of valence and local structure of Co [2,3]. Combining all XAS techniques the valence, local structure and magnetic properties of Co:ZnO as a function of the Co concentration can be determined in an unprecedented concentration range from 10% up to 60%, i.e. across the coalescence limit [4].

[1] A. Ney *et al.*, New. J. Phys. **12**, 013020 (2010).
[2] B. Henne *et al.*, Phys. Rev. B **95**, 054406 (2017).
[3] B. Henne *et al.*, Sci. Rep. **5**, 16863 (2015).
[4] V. Ney *et al.*, Phys. Rev. B **94**, 224405 (2016).