Resonant Inelastic X-ray Scattering of Binary and Ternary Vanadium Oxides

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3d transition metal oxides display a broad variety of electronic, magnetic and structural materials properties. The binary vanadium oxides V_2O_3 and VO_2 exhibit insulator-to-metal transitions at 160 K and 340 K, respectively. NaV_2O_5 is regarded to be the second example for an inorganic spin-Peierls (SP)compound, showing many materials properties consistent with a SP-transition at 34 K. LiV_2O_4 is a conducting nonmagnetic metal down to the lowest temperatures and is known to be the first heavy fermion (HF) d-electron material.

In the present work the electronic structure of these vanadium oxides has been studied by means of soft x-ray absorption spectroscopy (SXAS) and resonant soft x-ray emission spectroscopy (RSXES). The soft x-ray emission was recorded with a high-resolution Rowland-mount grazing-incidence grating spectrometer with a two-dimensional detector.

RSXES spectra were recorded for a series of excitation energies on resonances of the V L- and O K-absorption band. The V L- and O K-emission bands of the RSXES spectra possess considerable overlap. By resonant excitation we can tune the energy to the absorption thresholds thereby eliminating this overlap. Hereby we obtain the V 3d and O 2p projected density-of-states(DOS) of the valence band. Resonant inelastic x-ray scattering (RIXS) is found to be weak in V_2O_3, which we explain as being due to its metallic character at room temperature (RT). In contrast, VO_2 , which is semiconducting at RT, shows considerable RIXS features at the O K-emission band. Distinct RIXS structures are also visible in RSXES spectra of the insulator NaV_2O_5. Our observation, that RIXS is stronger for insulators and semiconductors than for metals can be taken advantage of for studying insulator-to-metal transitions in vanadium compounds.