Tuning electronic properties of transition metal oxides by means of redox processes

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In this presentation, we show the effect of reduction and oxidation on the electronic properties of the model transition metal oxide, i.e. titanium dioxide. These processes were studied at nanoscale using a multitude of techniques to provide a thorough characterization of the changes that occur in the studied system. Moreover, the experiments were performed in both ultra-high vacuum (UHV) conditions, as well as in oxygen-rich conditions, in order to comprehensively describe the changes in properties and to bring the results closer to applications.

The experiments revealed that the electronic properties may be tuned. In case of using reduction by means of annealing in UHV, ion sputtering, repeated ion sputtering and annealing, and oxidation by exposure to oxygen at room temperature. Using this range of methods, the conductivity of TiO2 can be changed from semiconductive-like to metallic-like. Furthermore, the work function of this crystal can be tuned in a wide range, from 3.4 eV to 5.0 eV. The key findings in the field of surface science were the description of the changes in electronic properties due to repeated sputtering and annealing. These results are important because they touch upon the very basis of every experiment in the field i.e. the preparation of crystals. This work can be used to foster greater reproducibility of experiments, as well to provide new means of designing experiments.