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Plasmas and catalysts

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In recent direction of research, plasmas are being more and more used for or in catalysis. The aim is either to find alternative routes for a large scale production of e.g. new gases or to increase catalysis efficiency of catalytic materials. There are two systems where plasmas work for catalysis; i) in synergy systems of beneficial interactions between plasma and materials, or ii) in systems where plasmas are used for design of catalyst systems.

For outlined presentation, the one of more important aspects connected with this research is a synergistic effect of plasma and catalysts, which is opening the new opportunities for applications. Low temperature plasmas which are featured by partially ionized gases, which consist of electrons, various ions, and neutral species like molecules, atoms, and excited species, have proven to be great sources for the surface manipulations or supplying building blocks for nanomaterials. Furthermore, the specific plasma-surface interactions are leading to synergistic effects, where very little is understood in terms of basic processes taking place. The catalytic activity of nanomaterials is determined by their size, faceting, presence of steps, defects, strain, oxidation state and support material. In plasma catalysis, all these nanomaterial factors are influenced by plasma, thus affecting the sequent catalytic process. To understand these processes at atomic scale and mechanisms taking place, we implemented different low pressure plasma treatments of nanoscale materials such as nanowires or nanoparticles. As results of interactions of various plasma species including electrons or neutral atoms, the intrinsic properties of nanomaterials change. These observations are supported by analytical methods such as TEM observations in order to unravel what is occurring on nanomaterial surface. Through the changes in the crystalline structure of material or reorganization of its surfaces, the functionality of materials in applications such as gas sensing, liquid purification, etc. is changed as well. Such modifications and conversions with different plasmas are presented for various cases of metal oxide nanowires or nanoparticles.