AN AQUEOUS SOLUTION APPROACH TO ADVANCED METAL OXIDE ARRAYS ON SUBSTRATES

Lionel Vayssieres
International Center for Young Scientists, National Institute for Materials Science, Tsukuba, Japan

The ability to design one-dimensional building blocks with tailored aspect ratio and to order them into large 3-D arrays is an important challenge scientists have to face to create smart and functionalized nanodevices. Our approach to control the size and shape of nanoparticles as well as the overall texture of particulate thin films is to tune their direct aqueous hydrolysis-condensation growth onto substrates by monitoring the interfacial thermodynamics of nanocrystals as well as their kinetics of heteronucleation. This is achieved by minimizing the surface energy at the water/oxide interface according to a general quantitative model based on Gibbs adsorption equation. Indeed, growing materials at very low interfacial tension, i.e. at thermodynamically stable conditions, allows the experimental control of the extension and rate of the nucleation and growth stages. Thus, different sizes, shapes, and orientations can be generated onto a variety of substrates. Consequently, the design and fabrication of novel devices with tailored and engineered three-dimensional architecture can be obtained from aqueous solution without template, surfactant, applied field, or undercoating. Such ideas will be demonstrated on transition metal oxides materials at nano-, meso-, and micro-scale, and illustrated on their growth as 3-D arrays with controlled orientations onto various substrates as well as the characterization of their electronic structure, photoelectrochemical, and magnetic properties.