

OVERVIEW/ABSTRACT

Modification of ceramic surfaces with nanostructures has been a very prolific area of research, producing very exciting materials for optical, mechanical, chemical and other applications. In case of metal nanoparticles-ceramic interfaces, modification of interfaces is often accomplished by post-treatment of ceramic surfaces using various synthetic techniques. Importantly, the published studies do not offer a pathway for *in-situ* tracking of nanoparticles formation, which could allow tuning of their properties during the growth rather than relying on post-mortem *ex-situ* analysis. Thus, there is a pressing need to develop facile *in-situ* synthetic methods that offer controlled fabrication of composite ceramics with desired properties.

This proposal offers a unique approach to engineering metal-ceramic surface structures by growing nanoparticles from doped ceramic *in-situ*, while observing formation of the nanostructures in real time using a range of state of the arts in-situ spectroscopic and novel microscopic techniques. The establishment of structure-property relations will be achieved by both experimental and theoretical methods, where particle size, metal-ceramic interfaces and shape, will be tuned by a relatively simple but yet novel and scalable approach. Our methodology of relying on such easy-to-control parameters as dopant type, concentration and temperature will allow us to tune particle size/interface morphology. *The desired tunable surfaces will be engineered to achieve high conversion of CO₂ to fuels, which is an extremely challenging but yet a very important reaction to facilitate sustainable fuel generation.*

It is important to mention that the proposed area of research is focused on a very novel topic that has never been funded by any funding agencies. Despite having no financial support to initiate collaborative efforts, the Professors Frenkel and Orlov have already obtained some initial results supporting the proposed research. The seed funding will allow two research groups to combine synthetic, characterization and theoretical approaches to develop large proposals. The outcomes of this project and potential future funding will have significant broader impacts on cleaner energy production, synthesis of new nanomaterials and development of novel experimental techniques.