Plamen Atanassov grew up in Bulgaria and graduated from the University of Sofia in 1987 specializing in Chemical Physics and Theoretical Chemistry. He joined the Bulgarian Academy of Sciences and became a Member of Technical Staff of its Central Laboratory of Electrochemical Power Sources (now the Institute for Electrochemistry and Power Systems). His initial work included materials solutions for metal-air batteries. During 1988/89, Plamen Atanassov was a visiting scientist in the Frumkin’s Institute of Electrochemistry, Moscow, Russia studying bio-electrochemistry of enzymes. He received his doctorate from the Bulgarian Academy of Sciences in Physical Chemistry, specializing in Electrochemistry under the guidance of Prof. Ilia Iliev and Prof. Evgeni Budevski.

Plamen Atanassov moved to the United States in 1992 and later became a research faculty with the University of New Mexico. During this period he was involved in development of a several electrochemical biosensor technologies for biomedical, environmental food safety and defense applications. In 1999 Plamen Atanassov joined Superior MicroPowders LLC (now Cabot-SMP) were he was a project leader in fuel cell electrocatalysts development. He returned to the University of New Mexico in 2000 as faculty member of the Chemical and Nuclear Engineering Department.

Currently Plamen Atanassov is the Director of UNM Center for Emerging Energy Technologies. He is the PI on AFOSR MURI “Fundamentals and Bioengineering of Enzymatic Fuel Cells”, which includes faculty from Columbia University, Northeastern University, Michigan State University, St. Louis University and University of Hawaii. Plamen Atanassov is the PI for the New Mexico DOE EPSCoR Implementation Award “Materials for Energy Conversion”, a concerted effort of UNM, New Mexico Tech, New Mexico State and Eastern New Mexico Universities. He is also the UNM Director for the NSF Industry/University Collaborative Research Center and has standing collaborations with scientists from LANL, SNL, NREL, ANL, ORNL, LBNL and funded programs with industrial partners such as: Daihatsu, Ballard, Sharp, Cabot, IRD, Akermin and Lynntech.

Plamen Atanassov ’s research programs include development of non-platinum electrocatalyst for fuel cells, new materials and technologies for micro-power sources, enzymatic bio-fuel cells, sensor systems design and integration of micro-analytical systems.
Hierarchically Structured Fuel Cell Electrocatalysts
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Nano-structured materials play a vital role in electrochemical power source technologies: batteries, super capacitors and fuel cells. Their main role is in increasing of volumetric (and in some cases, gravimetric) power density, provide for higher energy density and facilitate increased rate of drain. Nano-materials contribute to the enhancement of the catalytic properties of the electrodes, dramatically improve interconnectivity of porous matrixes and revolutionize mass-transport characteristics on micro- and meso-scale. Detailed understanding of these processes allows even broader exploration of nano-materials for energy conversion. Structural properties of these materials are making possible new design solutions and provoke a new stage in power source systems engineering. All these will bring substantial benefit if manufacturing of such materials could meet the demand in volume, performance and reproducibility.

This presentation brings examples from two materials synthesis platforms: aerosol processing in a format of spray pyrolysis and colloidal approach based on sol-gel templating of microemulsions. Both approaches have been used at UNM over the last decade to design electrocatalyst powders with varied chemical structure and desired morphology for fuel cell and related applications. The spray-based process results in formation of unique spherical, micronsized aggregates consisting of sub-micron electrocatalyst particles where the nanometer sized active phases (Pt, Pt-Ru, Pt-Sn, metal alloys, metal oxides, composite and non-noble metal electrocatalysts) are highly dispersed on the surface of carbon supports. Microemulsion-derived materials have three levels of morphology control: nanopores derived from micellar structure of the surfactant used, mesopores templated on the microemulsion droplets and macrostructucted particles resulting from sheer mixing. We have developed these two approaches to produce not only traditional electrocatalysts (PGM and their allows supported as decorative phase on carbon blacks) but also a whole new set of reactive oxide and conductive oxide materials that serve as co-catalysts or non-carbonaceous supports. Synthesis of non-platinum electrocatalysts based on transition metals and N-containing carbonaceous materials obtained by both methods will be discussed as well. Such hierarchical structures are advantageous in enhancement of the fuel cell performance since they correspond to the different levels of transport in the corrugated electrode matrixes. A wide variety of materials can be made by these methods in which not only the composition but also the microstructure can be varied. It is the combination of these attributes - control over microstructure at a number of different length scales and composition, simultaneously - that is extremely important to the performance of the electrocatalyst powder in a fuel cell.