Development of 1-Dimensional Functional Ceramic Nanofibers by E-spinning

One-dimensional materials or structures are those exhibiting at least one dimension less than 100 nm; average thickness of human hair is ~50,000 nm. There is a window to develop nanoarchitectured ceramics for achieving benign tissue engineering, photocatalysts, high performance gas sensors, photovoltaics and many other interesting devices. Recently, bottom-up approaches have received increasing attention and electrospinning is one of them. Electrospinning has been successfully used for making polymer nanofibers for the past 70 years. It has seen its use in ceramics only for the past 3 years for the synthesis of 1-D nanofibers. Electrospinning uses electrical forces to produce novel fibers of diameters in the range of 3 to 1000 nm, depending upon the strength of the applied voltage between a drop of the precursor solution (or melt) and the collecting surface.

We have employed electrospinning for fabricating a host of functional ceramics such as stabilized zirconia (YSZ), doped ceria (GDC), strontium cerate (SrCeO3), titania (TiO2) alumina (Al2O3) and lanthanum strontium manganite (LSM) as 1-dimensional nanofibers. Various analytical techniques such as X-ray diffraction (XRD), Raman spectroscopy (RS), thermogravimetry and differential scanning calorimetry (TG/DSC) and transmission and scanning electron microscopy (TEM/SEM) together with the selected area electron diffraction (SAED) and energy dispersive spectroscopy (EDS) were employed for characterizing the processed fibers.

A project to fabricate 1-D nanofibers of functional ceramics (such as those exhibiting piezoelectric and/or giant magnetoresistance behaviors) is being initiated.

This project is open for participation by the undergraduate (independent study/honor thesis) as well as by graduate students. This would give the student a unique opportunity to get excellent hands-on experience on the use of a host of sophisticated instruments such as those listed above and many more. If interested, please contact Dr. Abdul-Majeed Azad at: abdul-majeed.azad@utoledo.edu or 530-8103.