LOW DENSITY MATS AND FOAMS WITH METAL COMPONENTS
Or
HOW STRONG IS THAT SQUISHY METAL THING?

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Non-woven structures for filters or catalysis applications are often formed from wet-laid melt blown or spun-bounded fibers, where the fibers are on the order of microns in diameter. Ultra-filtration applications use finer diameter fibers (100s to 1000 nm) which can be formed via electrospinning. We aim to create high surface area, low density metallic systems for fuel filters, catalyst supports, and high pressure water filtration. In this current work we explore two types of foam/mat structures formed using electrospinning as the initial technique. In the first case, we electrospin hydrophobic and hydrophilic polymers and examine their ability to subsequently be processed using electroless deposition of copper to form nm-scale copper particles which are well adhered to the underlying electrospun mat. Electroless deposition on these polymers was carried out using either a pre-treatment of PdCl2 solution or from a copper sulfate solution. The resulting metallization was quantified by the particle size and distribution of metallization as a function of processing conditions, and chemistry and crystallography was determined using both FTIR spectroscopy and X-ray diffraction. Finally, the effect of metallization on the mechanical response of the mat to pressure (a key parameter to provide adequate flow rates through filters) was explored.

The second structure examined uses electrospinning of a polymeric precursor containing metal acetate compounds in the polymer during spinning. Using a combination of oxidation and thermal reduction on electrospun fibers allows for multiple length scales of structural feature control, with meso-scale pores dominated by the fiber diameter and spacing, and ligament scale porosity and roughness dominated by thermal processing and diffusive processes. We demonstrate the fabrication of Cu-Ni alloys as a model solid solution structure, and create and characterize the architecture and microstructure of these materials between pure Cu and 50/50 Cu-Ni; any composition in this range is accessible using simple wet chemistry of the polymeric precursor used for electrospinning. The pyrolyzation controls the larger length scale, and the initial oxidation step creates a mixed oxide structure for the alloy systems. Subsequent reduction causes homogenization of the resulting ligaments. The alloy foams, with porous ligaments with dimensions on the order of 200 nm, and pores on the order of 50 nm, exhibit a strength four times that of the pure copper films with 400 nm ligament dimensions. The increase in strength is attributed to both solid solution strengthening and also fractionally impacted by the length scale of the ligaments.

Biosketch:
Prof. David Bahr is currently the Head of Materials Engineering at Purdue University. Prior to this position he was Director and Professor of Mechanical and Materials Engineering at Washington State University. He received his BS and MS in MSE at Purdue University, and a PhD in Materials Science at the University of Minnesota. He worked for a short time at Sandia National Laboratories during his PhD before starting as a faculty member in the School of MME at WSU in 1997. In 2000 he won the Presidential Early Career Award for Scientists and Engineers for his work with Sandia on DOE stockpile stewardship, in 2003 he received the Bradley Stoughton Award from ASM International, and in 2007 received the Robert Lansing Hardy award from TMS (where he served as

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