Mark A DeCoster et al., Madridge J Nanotechnol Nanosci. 2016
http://dx.doi.org/10.18689/2638-2075.a1.001

Novel synthesis and characterization of scalable metallic nano-biocomposites for interaction with cells

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We have recently reported the novel synthesis of a scalable nano-biocomposite containing copper and the amino acid dimer cystine. The biocomposites were synthesized at physiological temperature (37 degrees Celsius) and in a liquid medium, with typical synthesis time of 3-7 hours. Two copper sources successfully resulted in biocomposites: copper nanoparticles (CuNPs), and copper sulfate. Both copper sources resulted in very high-aspect ratio structures (HARS), with diameters scaling from 20 nm to a few microns, and lengths scaling from hundreds of nanometers to hundreds of microns as determined by scanning and transmission electron microscopy and white-light microscopy. Synthesis using copper sulfate resulted in "cleaner" synthesis in that the copper sulfate went fully into solution, while the CuNPs often were not fully transformed during the synthesis. Once synthesized, the HARS were remarkably stable, for at least a year in both liquid (water) and dried form. Furthermore, they had very low agglomeration (clumping), which made transfer and concentration of the HARS by centrifugation much more feasible. While length of the individual HARS could not be controlled during the synthesis, post-synthesis the average length could be decreased using sonication. Furthermore, solutions at extreme pH values (both basic and acidic), were able to degrade the HARS post synthesis. While starting CuNPs were very toxic to cells in vitro at 25-50 micrograms per ml, including to brain tumor cells, the CuNP- and copper sulfate-derived HARS were much less toxic on a per mass basis as determined by the MTT metabolic assay. Additionally, we found that over time the copper containing HARS could be degraded in cell culture conditions, bound to phagocytic cells of the brain (microglia), and could be taken up by 3-dimensional (3D) cell spheroids. Thus, these novel nano- and micro-biocomposites containing copper and cystine could provide a degradable platform for directing cell engineering including destruction of cancer cells. Since these biocomposites are formed under physiological conditions and include the amino acid dimer cystine, they may be more amenable to functionalization and utilization in 2D and 3D cell systems for both short-term and long-term cell engineering.

Biography:

Dr. DeCoster is the James E. Wyche III endowed Associate Professor in Biomedical Engineering at Louisiana Tech University in Ruston, Louisiana and is a member of the Institute for Micromanufacturing there. He received his Ph.D. in Biochemistry and Molecular Biophysics from the Medical College of Virginia/ Virginia Commonwealth University, and his B.S. in Biology from the College of William and Mary. His research interests include combining nanotechnology with cell biology to understand the brain and disease states such as cancer. In 2010 Dr. DeCoster founded Nanogaia, a startup company developing novel nano-biological hybrid materials and interfaces for cells in 2D and 3D environments. Dr. DeCoster has published over 65 peer-reviewed papers with over 1,950 citations of this work. He has served extensively as a reviewer for the National Institutes of Health and the National Science Foundation, and his lab group is currently funded by multiple federal and state grant awards.