Self-fitting, Shape Memory Polymer Scaffolds for Bone Defect Repair

Melissa A. Grunlan, Ph.D.
Charles H. and Bettye Barclay Professor of Biomedical Engineering
Texas A&M University

Abstract

Shape memory polymer (SMP) scaffolds were prepared having the capacity to conformally "self-fit" into and heal irregular bone defects. Initially, porous scaffolds were fabricated via photo-crosslinking of *linear*-poly(ε-caprolactone) (PCL) diacrylate using a solvent casting/particulate leaching (SCPL) method employing a fused salt template. Following exposure to warm saline at T > Tt_{trans} (T_{trans} = ~T_m of PCL), the scaffold became malleable and could be pressed into an irregular model defect. Subsequent cooling caused the scaffold to lock in its temporary shape within the defect. In this this talk, strategies to create a tissue-safe fitting temperature, accelerate the rate of degradation, and to enhance bioactivity will be discussed. These approaches include the use of a star PCL architecture, a semi-interpenetrating polymer (semi-IPN) design that incorporates poly(L-lactic acid) (PLLA), and the addition of Bioglass to form composites.

Biosketch

Melissa Grunlan is a Professor of Biomedical Engineering at Texas A&M University (TAMU) and Holder of the Charles H. and Bettye Barclay Professorship in Engineering. She is also a TAMU Chancellor EDGES Fellow and Presidential Impact Fellow. She holds courtesy appointments in the Department of Materials Science & Engineering and the Department of Chemistry. Prof. Grunlan obtained a B.S. in Chemistry and M.S. in Polymers in Coatings from North Dakota State University and a Ph.D. in Chemistry from the University of Southern California. Her work is focused on the development of synthetic polymeric biomaterials for implanted medical devices and for regenerative engineering. She is a Fellow of the American Institute for Medical and Biological Engineering (AIMBE), the American Chemical Society (ACS), the ACS PMSE Division, and the Biomedical Engineering Society (BMES). Prof. Grunlan is also a Senior Member of the National Academy of Inventors. http://grunlanlab.tamu.edu/

Protective Nanocoatings from Polyelectrolytes: Flame Retardancy, Super Gas Barrier, and Heat Shielding

Jaime C. Grunlan
Leland T. Jordan '29 Chair Professor
Department of Mechanical Eng., Materials Science & Eng. and Chemistry
Texas A&M University, College Station, TX 77840

Abstract

Layer-by-layer (LbL) assembly is a conformal coating "platform" technology capable of imparting a multiplicity of functionalities on nearly any type of surface in a relatively environmentally friendly way. At its core, LbL is a solution deposition technique in which layers of cationic and anionic materials (e.g. nanoparticles, polymers and even biological molecules) are built up via electrostatic attractions in an alternating fashion, while controlling process variables such as pH, coating time, and concentration. Here we are producing nanocomposite multilayers (50 – 1000 nm thick), having 10 – 96 wt% clay, that can be completely transparent, stop gas permeation, and impart extreme heat shielding to polymeric substrates. In an effort to impart flame retardant behavior to fabric using fewer processing steps, a water-soluble polyelectrolyte complex (PEC) was developed. This nanocoating is comprised of polyethylenimine and poly(sodium phosphate) and imparts self-extinguishing behavior to cotton fabric in just a single coating step. Adding a melamine solution to the coating procedure as a second step renders nylon-cotton blends self-extinguishing. More recently, a PEC coating was developed for polyester-cotton. It passes vertical flame testing after five standard washes or 8 hours in boiling water. Either of these two coating techniques can be deposited using flexographic printing or spray-coating tools. Opportunities and challenges will be discussed. Our work in these areas has been highlighted in *C&EN*, *ScienceNews*, *Nature*, *Smithsonian Magazine*, *Chemistry World* and various scientific news outlets worldwide. For more information, please visit my website: http://nanocomposites.tamu.edu

Biosketch

Dr. Jaime Grunlan is the Leland T. Jordan '29 Chair of Mechanical Engineering at Texas A&M University, where he has worked for more than 18 years. He holds joint appointments in the Department of Materials Science and Engineering and the Department of Chemistry. His research focuses on thermal and transport properties of polymer nanocomposites. He is a world leader in organic thermoelectric materials, super gas barrier layers, and environmentally-benign, flame retardant nanocoatings. He holds 14 issued U.S. patents and several EU patents that have been licensed to more than 10 companies. He has published more than 200 journal papers, with more than 23,000 citations. Dr. Grunlan has graduated 27 PhD students and has mentored more than 50 undergraduate students in his research laboratory. His work has been highlighted in *Smithsonian Magazine* and the *New York Times*. He is an Editor of the *Journal of Materials Science*, Associate Editor of *Green Materials*, and serves on the International Advisory Board for *Macromolecular Rapid Communications* and *Macromolecular Materials and Engineering*. In 2018, Prof. Grunlan became a Fellow of the American Society of Mechanical Engineers (ASME) and was awarded a *doctorate honoris causa* (i.e. honorary doctorate) from the University of South Brittany (Lorient, France). In 2019, he became a Senior Member of the National Academy of Inventors (NAI).