Spring 2019 Joint Colloquium
Materials Department & Materials Research Laboratory

Professor Matthew Begley
Materials Department and Department of Mechanical Engineering
University of California, Santa Barbara

Friday, April 26th, 2019
11:00 am, ESB 1001

Bone Implants Based on Additively-Manufactured Porous Structures

The emergence of additive manufacturing has renewed interest in architected materials, which enable improved combinations of properties, notably high specific strength/stiffness, internal mass transport, and enhanced structural damping. Bone implants to avoid limb amputation are a highly compelling application for integrated structural and process design, as they require rapid fabrication of complex porous structures that promote internal bone growth. Examples of patient-specific "custom" implants (currently utilized in several hundred surgeries per year) will be presented to illustrate the challenges and opportunities of transformative clinical solutions. Progress towards addressing these challenges will be described, starting with the mechanical behavior of regularized lattices that inform the design and development of robust structures. Experimental characterization of 3D-printed titanium lattices will be used to highlight connections between design, processing and mechanical performance. The results illustrate that geometry, processing protocols and performance cannot be decoupled, and hence require new frameworks for component development. Finally, the multifunctional design objectives of bone implants will be used to illustrate the advantages of 3D-printed lattices, namely the promotion of bone-implant fusion by through controlled surface roughness, lattice topology and contact geometry. The results from models and experiments on bone mimics strongly point towards optimal lattice configurations that promote fixation while limiting damage to adjacent bone. The talk will conclude with a brief description of future work addressing the integration of design, fabrication and biomechanical performance of bone implants.

Bio

Matthew R. Begley is Professor of Mechanical Engineering and Professor of Materials at the University of California, Santa Barbara. He received his Ph.D. in mechanical engineering from UCSB in 1995 and was a post-doctoral fellow at Harvard from 1995-1997. Prof. Begley joined UCSB in 2010, following faculty positions held at the University of Virginia (2001-2009). Prof. Begley's research thrusts are: (*i*) additive manufacturing in bioengineering and aerospace, (*ii*) field-assisted 3D printing of multi-phase soft materials, and (*iii*) multilayered systems with an emphasis on interface stability. He has been an invited speaker at the International Congress on Fracture (2001), the Advanced Metallization Conference (2003), Gordon Conference on Small-Scale Mechanical Behavior (2006), the Gordon Conference on Microfluidics (2013), Invited Keynote Speaker at the 2016 □TAS Meeting and the Gordon Conference on Corrosion (2019). Professor Begley was co-leader of the winning team in DARPA's Digital Manufacturing, Analysis, Correlation and Estimation Challenge (2010), and is a recipient a Fraunhofer-Bessel Award from the Humboldt Foundation in Germany (2013).

https://engineering.ucsb.edu/~begley/home.html

Hosted by Carlos Levi and Bob McMeeking.