Additive Manufactured Thermal-Mechanical Ultralight Materials for Lightweight Vehicles

Relevance to the Automotive Industry:	Lightweight, robust materials are essential to boost vehicle fuel economy while maintaining functionality, safety and performance. A 2011 NREL study suggests that reducing the mass of an internal combustion engine vehicle by 10% improves the fuel economy by 6%-8%. This research investigates additive manufacturing with ultralight weight materials (<1000kg/m^3) and in-situ sensing and actuation.	
Research Location:	**TU Darmstadt** Datenverarbeitung in der Konstruktion (DiK)	**Virginia Tech** Advanced Manufacturing and Metamaterials Laboratory
Homepage (Engl.):	http://www.dik.tu-darmstadt.de	http://www.me.vt.edu/VTPL http://www.raynexzheng.com/
Faculty Mentor:	Prof. Dr.-Ing. Reiner Anderl	Prof. Xiaoyu (Rayne) Zheng, Ph.D.
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Project Description: June 5 - Aug 11, 2017; (10 weeks, 40h/week)	In this transatlantic project, two NSF REU students (one within a German team, and one within a US team) will design novel ultralight weight materials and manufacture test geometries using high resolution 3D printing technologies. They will explore the resulting stiffness, thermal stability, and impact and energy absorption abilities. They will also explore the new multi-functional design space of these new materials, such as impact sensing and actuation in next generation ultralight weight vehicles. **PHASE A** (2-3 weeks): During this introductory phase, the two NSF REU students will review relevant research and investigate existing software. **PHASE B** (3 weeks): GERMANY: The student will be developing a suitable set of CAD models to be used for fabricating parts for testing, and will be developing associated G-code to drive the additive manufacturing equipment. USA: The student will explore ultralight weight structures and simulate their mechanical properties, and practice the manufacture using additive manufacturing technologies. **PHASE C** (3 weeks): GERMANY: The student will explore methods for data representation of multi-material systems in CAD. USA: The student will perform mechanical testing of fabricated parts based on the CAD models and G-code developed in Germany. As time permits, the student will also explore integration of electronic materials for in-situ sensing and actuation of additive manufactured parts. **PHASE D** (1-2 weeks): Finally, the two NSF REU students will document the research performed, prepare a written report, to support subsequent publications, and deliver an end-of-summer presentation on the research performed.	
Target publications:	• **JOURNALS: Smart Material and Structures; Advanced Materials; Journal of Micro and Nano manufacturing** • **CONFERENCES: SPIE Smart Structures; Lightweight Vehicle Manufacturing; Solid Freeform Fabrication Symposium**	
Necessary Skills/ Knowledge:	• Novice programming skills (e.g., MATLAB, MS Excel, C, C++) • CAD modeling	
Desirable Skills/ Knowledge:	• Ansys, Multi-Body Dynamics software (e.g., ADAMS, DADS, CarSim) • LabView programming	
Additional Online Resource(s):		

NSF REU Students must have completed at least two semesters of engineering studies prior to the proposed summer research, and they must have at least one semester remaining before they can earn their BS in Engineering.