

## Laser Forming of Metal Foam

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### Abstract

Metal foam offers unique properties of high strength/weight ratio and shock absorption. Mechanical bending often leads to thin cell wall fracture and cell collapse. Laser forming has shown promise of shaping metal form without these defects. Infrared imaging was used to characterize the transient temperature response of metal foam to stationary and moving laser sources. Similarly, digital image correlation (DIC) was employed to characterize the strain evolution. The resulting data were analyzed to elucidate why metal foam can be laser-formed despite its high bending stiffness and to verify whether the temperature gradient mechanism (TGM), well established in solid sheet metal forming, is valid for metal foam. A modified MTGM was proposed and validated. The study was aided by numerical investigation, in which an equivalent model, a Kelvin-cell based model, and an X-ray computed tomography (CT) based model were comparatively evaluated. The study was extended to sandwich panels, where metal foam cores are sandwiched between solid metal face sheets. The extension was focused on the differences in response by the foam core and the solid face sheets to laser irradiation. It also investigated the effect of interface on thermal and mechanical behavior of these panels under laser forming. This work is in collaboration with Boeing under the sponsorship of a GOALI grant from National Science Foundation.

### Bio

Y. Lawrence Yao is Professor of Mechanical Engineering at Columbia University, where he directs the Advanced Manufacturing Laboratory. Yao served as Chair of Mechanical Engineering Department at Columbia University between 2005 and 2011. Yao has pioneered research in laser materials processing, including laser assisted removal, shaping, joining, and property modification of various materials, and innovative laser applications in renewable energy, biomedical, and art restoration fields. Yao received the Milton C. Shaw Manufacturing Research Medal from American Society of Mechanical Engineers (ASME) in 2015 and the Blackall Machine Tool and Gage Award from ASME in 2006. Yao is a Fellow of ASME, SME and Laser Institute of America and currently serves as Editor, Journal of Manufacturing Science and Engineering of ASME. Yao received Ph.D. from the University of Wisconsin-Madison.

