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## *Time-Resolved Imaging of Nanosecond Laser Ablation Processes*



*David A. Willis*

*Associate Professor*

*Department of  
Mechanical  
Engineering,*

*Southern Methodist  
University (SMU)*

**Abstract:** Laser microprocessing is used in a number of technologies in which micro-scale features are required, including micromachining, laser-induced forward transfer, and surface texturing. In order to achieve small feature sizes with minimal heat affected zones, lasers with pulse durations of a few nanoseconds are often used. A variety of thermal processes may be induced by these short pulses, including melting, liquid flow, vaporization, and explosive boiling, all of which can occur on a nanosecond time scale. Due to the short time scales, understanding the governing thermal-fluid processes can be difficult. The presentation will discuss our efforts to understand liquid-vapor phase change during laser ablation using a time-resolved shadowgraph imaging system. Experiments with aluminum targets reveal direct observation of vaporization and phase explosion, as well as shock waves in the ambient air induced by the rapid material removal. Images captured vaporization of aluminum below  $5.2 \text{ J/cm}^2$ , while at higher fluences a mixture of droplets and vapor was observed as a result of phase explosion. The measured shock wave position as a function of time is used to estimate the pressure behind the shock wave.

**Biography:** Dr. David A. Willis is an Associate Professor in the Department of Mechanical Engineering at Southern Methodist University (SMU). He received his B.S. degree from North Carolina State University in 1995 and his M.S. and Ph.D. degrees from Purdue University in 1997 and 2001, respectively. His areas of research interests are heat transfer, phase change, and fluid mechanics problems associated with short pulse laser-material interactions. His research involves experimental studies of laser microfabrication, high power laser-ablation, laser texturing, and laser-induced forward transfer. He is a member of the ASME, Laser Institute of America, American Society for Engineering Education, and Senior Member of the SPIE. He has received the ASME North Texas Young Engineer of the Year Award, the SMU Rotunda Outstanding Professor Award, the SMU Golden Mustang Award, the Altshuler Distinguished Teaching Professor award at SMU.