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Microenergetics: Combustion and Detonation at Sub-Millimeter Scales[1]

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At Sandia National Laboratories, we have coined the term "microenergetics" to describe sub-millimeter energetic material studies aimed at gaining knowledge of combustion and detonation behavior at the mesoscale.[1] Our approach is to apply technologies developed by the microelectronics industry to fabricate test samples with well-defined geometries. Substrates have been fabricated from materials such as silicon and ceramics, with channels to contain the energetic material. Energetic materials have been loaded into the channels, either as powders, femtosecond laser-micromachined pellets, or as vapor-deposited films. Ignition of the samples has been achieved by simple hotwires, integrated semiconductor bridges, and also by lasers. Additionally, grain-scale patterning has been performed on explosive films using both oxygen plasma etching and femtosecond laser micromachining.[2] We have demonstrated simple work functions in microenergetic devices, such as piston motion,[1] which is also a relevant diagnostic to examine combustion properties. Detonation has been achieved in deposited explosive films, recorded by high-speed photography.[3] A review of progress on manufacturing and testing will be presented, as well as historical perspectives and future directions.

[1] A. S. Tappan, et al., 12th International Detonation Symposium (San Diego, CA, 2002).
[2] A. S. Tappan, et al., 36th International Annual Conference of ICT, combined with 32nd International Pyrotechnics Seminar (Karlsruhe Federal Republic of Germany, 2005).
[3] A. S. Tappan, et al., 13th International Detonation Symposium (Norfolk, VA, 2006).

[1]Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.