Lab-on-a-Chip ICF Target Manufacturing: The manufacture of inertial confinement fusion (ICF) foam capsules is a complex, low-yield process that requires labor-intensive effort to manufacture and identify acceptable targets. Technologies designed to improve this process based on electric-field mediated microfluidics are currently under development at LLE. The "lab-on-a-chip" concept miniaturizes and automates the process, and makes it more deterministic by incorporating precise electronic control into critical phases of the process. LLE in collaboration with the University of Rochester Department of Electrical and Computer Engineering demonstrated the assembly of oil-water emulsions[1] (precursors for the foam capsule) of the required volumes using the lab-on-a-chip concept (Figs. 1 and 2). Spherical symmetry in the emulsion was achieved with the dielectrophoretic force from a high-voltage (10 kV), high-frequency (10 MHz) electric field to offset buoyancy effects. This formed a well-centered emulsion, a prerequisite for a uniformly thick foam wall, within 100 s (Ref. 2) (Fig. 3). This demonstration establishes the prospects and capabilities of electric-field–based microfluidics, and defines limitations on those foam chemistries that can be employed with this concept. Within these constraints, General Atomics Inc., has demonstrated[3] a photoinitiated methodology for formulating low-density resorcinol-formaldehyde foam material to test with this technology. Future work will integrate the two microfluidic processes with the new chemistry for making the foam.

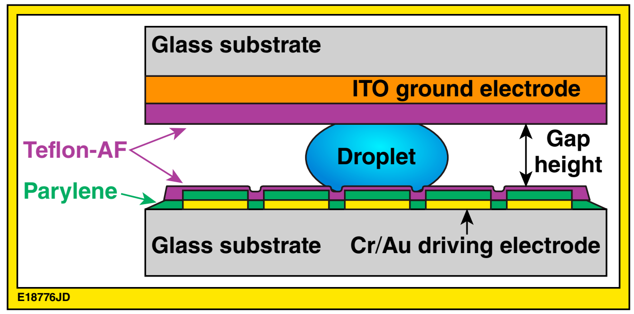

Figure 1. The patterned glass structure used to dispense and move droplets of oil and water is shown in cross-section.

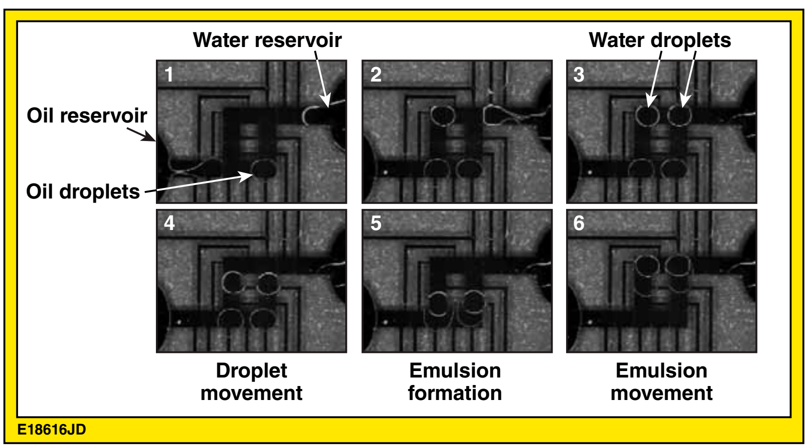

Figure 2. Time-lapse images show the formation of droplets of oil and water from two reservoirs (1– 3); movement of the droplets (4); combination of the droplets to form an emulsion (5), and, finally, movement of the emulsion.

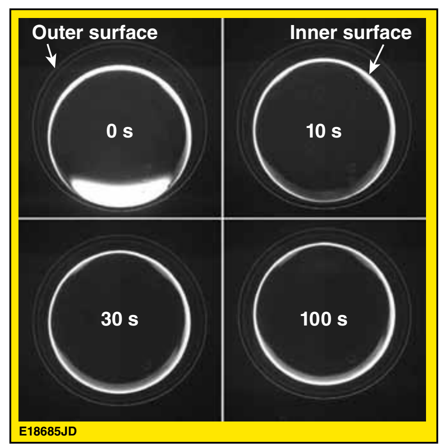

Figure 3. Time-lapse images of an oil-in-water emulsion suspended in oil is shown in a dark field image. The inner and outer surfaces are defined by the bright rings. The buoyancy mismatch has the oil droplet initially at the bottom of the water droplet and supported by surface tension. Applying an electric field (10^4 V/m) centers the two droplets within 100 s.

Omega Operations Summary: The Omega Laser Facility conducted 99 target shots in December (89 on the 60-beam OMEGA laser and 10 on the OMEGA EP laser) with an average experimental effectiveness of 94.9% (95.5% for OMEGA and 90% for OMEGA EP). Twenty-nine target shots were taken for NIC experiments led by LANL and LLE and the HED program accounted for 24 target shots taken by teams led by scientists from LANL and LLNL. An NLUF experiment by the University of California, Berkeley, carried out 7 target shots; the University of Michigan Center for Radiative Shocks (CRASH) conducted 8 shots; 24 shots were taken by two LBS experiments led by the LLNL; and 7 shots were dedicated to a CEA experiment.

1. W. Wang, T. B. Jones, and D. R. Harding, Fusion Sci. Technol. **59**, 240 (2011).
2. Z.-M. Bei, T. B. Jones, and A. Tucker-Schwartz, J. Electrost. **67**, 173 (2009).
3. R. R. Paguio *et al*., presented at the 2010 MRS Fall Meeting, Boston, MA, 29 November–3 December 2010 (Paper BB12.5).