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Plasma Breakdown in Bubbles: Capturing Realistic Bubble Shapes using Direct Numerical Simulation NAVEEN PILLAI, IGOR BOLOTNOV, KATHARINA STAPELMANN, Department of Nuclear Engineering, North Carolina State University — The ignition of plasmas in liquids has garnered a lot of attention in the past decade for applications ranging from usage in medical instrumentation to manipulation of liquid chemistry. While direct liquid ignition often requires prohibitively large electric fields to initiate breakdown, targeting streamer formation in bubbles submerged in a liquid with a higher permittivity can lower the requisite external field strength by an order of magnitude. This work utilizes 3-D direct numerical simulation (DNS) to simulate the precise bubble shapes formed in a full-scale model of our experimental setup. Due to the vast difference in timescales between fluid dynamics and plasma formation, plasma breakdown can be fully simulated within a single flow solution timestep. Thus, we use a 2-D plasma hydrodynamics model to capture the streamer behavior using static bubble geometry generated through the DNS code. In a frozen bubble just before collision with the powered electrode (+30 kV), we saw streamers propagating from the leading edge (closest to the powered electrode) to the trailing edge (closest to the ground). Preliminary computational results from a pin to pin setup with the same frozen bubble showed streamers propagating along the edge of the bubbles rather than through the body.

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