

Proton transfer through a floating water bridge

An aqueous electrohydrodynamic liquid bridge, aka "floating water bridge", is an intriguing phenomenon arising from the exposure of two vessels filled with pure water to a potential difference of 10-20kV. Electrochemically the system can be seen as a high voltage electrolysis with the bridge acting as protonic resistor allowing the concentration of protons and hydroxyl ions in the anolyte and catholyte, respectively. In the present work the proton transport through the bridge is visualized using shadowgraphy. Depending on polarity and isotopic composition of the water, different shadowgraphic results were obtained. For light water when the high potential was applied to the anode, ring-like structures appeared in the bridge, however, a high voltage cathode produced only irregular structures in the bridge. For the case of heavy water only irregular structures were observed regardless of which electrode was placed on high potential. The proton density varies in the bridge with app. 100Hz due to a vortical structure in the shear layer forming in the bidirectional flow approaching the bridge from the anode side. These varying concentrations in the protonic, charged water act as a seeding to the ring like structures forming in the bridge water. In all cases the shadowgraphic structures moved from the anode (positive electrode) to the cathode independent from the water surface flow with velocities between 30 and 40 cm·s⁻¹.