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Optical Characterization of Underwater Contact Mechanics

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For survival in extreme environments, organisms have evolved adhesive mechanisms and materials that out-compete those of human technology. While chemistry of underwater bio-adhesion is a source of valuable insight, the mechanics by which surfaces expel water and come in contact underlies critical understanding of natural solutions and evaluating biomimetic analogs. Hydrophobicity of an adhesive surface has been shown to be crucial in removing water from a hydrophilic substrate, but the resulting contact is typically heterogeneous, with patches of unevacuated water. Thermodynamically, the hydrophobic part of any adhesive or surface drives the water out in presence of any other akin moiety due to long-range hydrophobic forces. In this work, we present a simple, FTIR-based imaging technique to spatially resolve and quantify thickness of nanoscopic puddles formed between two solids in contact under water. The technique is validated by comparing measured air gap thickness of a glass lens in contact with glass prism with Hertzian contact theory, and then applied to characterize the drainage and formation of patches of water as a soft PDMS lens approaches a functionalized and a pristine glass surface at varying speeds. The work paves the way for better characterization of interfaces in contact under water and can find application in adhesive development, biological study and tribology.

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