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Capillarity-Driven Gas–Liquid Flow Control from Boiling to Water Electrolysis

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Abstract

The performance of both boiling heat transfer and water electrolysis is fundamentally limited by gas–liquid flow conditions near solid interfaces. In boiling, vapor formation close to the heated surface obstructs liquid supply and leads to the critical heat flux. In water electrolysis, gas generation and accumulation near the electrode surface hinder mass transport, thereby limiting current density and reaction efficiency.

This lecture introduces a capillarity-driven approach to gas–liquid flow control originally developed through studies on boiling enhancement using honeycomb porous structures, and discusses its extension to water electrolysis. By spatially separating liquid supply and gas removal through structural design, gas–liquid conditions near the functional interface can be precisely controlled.

Experimental results demonstrate that such gas–liquid flow control enables higher heat flux in boiling and improved electrochemical performance in water electrolysis. These findings suggest that capillarity-driven gas–liquid flow control provides an effective and shared design strategy for enhancing performance in both boiling and water electrolysis.