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Leidenfrost state suppression at ultrahigh temperatures ARJANG SHAHRIARI, JILLIAN WURZ, VAIBHAV BAHADUR, University of Texas at Austin — The Leidenfrost effect is the formation of a vapor layer between a liquid and an underlying hot surface which severely degrades heat transfer and results in surface temperature overshoots. We demonstrate and analyze electrostatic suppression of the Leidenfrost state at ultrahigh surface temperatures. A concentrated electric field across the vapor layer can attract liquid towards the surface and promote wetting. This principle is successful even at ultrahigh temperatures. Elimination of the vapor layer increases heat dissipation capacity by more than one order of magnitude. Heat removal capacities exceeding 500 W/cm^2 are reported, which is a significant advancement in boiling heat transfer. The underlying science can be understood via a multiphysics analytical model which captures the coupled electrical-fluid-heat transport phenomena underlying Leidenfrost state suppression. The physical insights gained are used to devise and demonstrate a novel electrostatic suppression technique which does not need any surface modifications. Overall, this work uncovers the physics underlying dryout prevention and demonstrates electrically tunable boiling heat transfer with ultralow power consumption.

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