Role of nanoscale roughness in the heat transfer characteristics of thin film evaporation

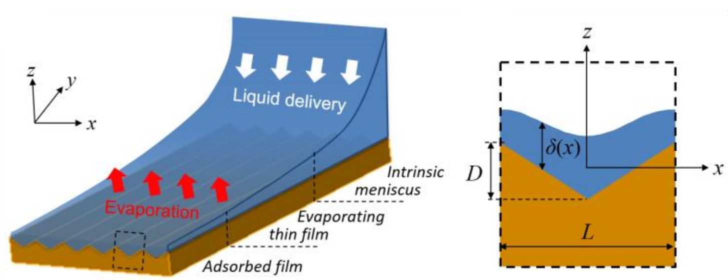
Faculty: S. V. Garimella, J. A. Weibel **Student: H. Hu**

OBJECTIVE

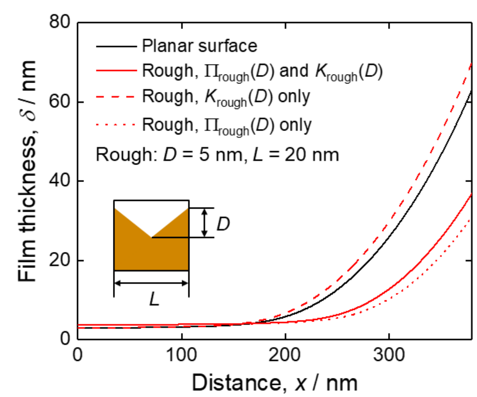
Develop a theoretical model to account for the effect of nanoscale roughness on thin film evaporation.

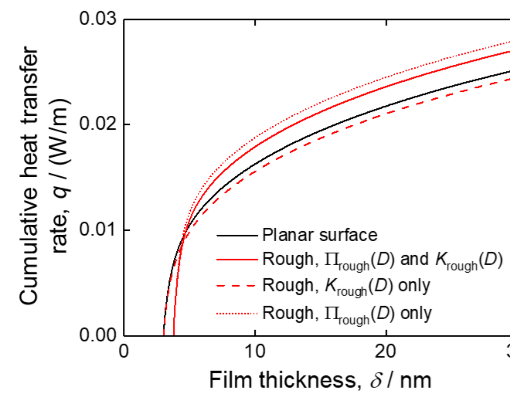
APPROACH

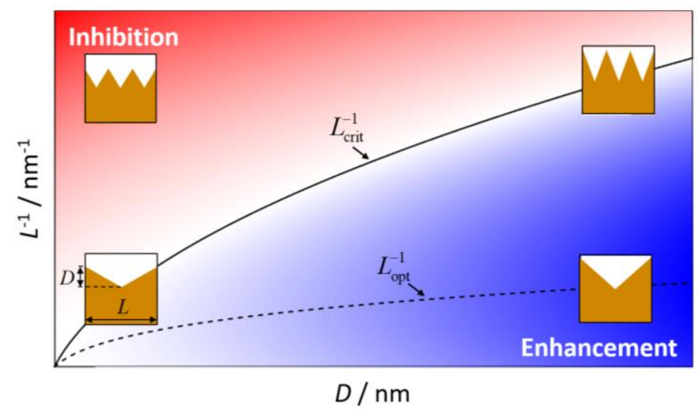
- Calculate roughness-affected disjoining pressure (Π) and permeability (K).
- Determine the heat flux by balancing evaporation and liquid flow driven by capillary and disjoining pressure.



RESULTS







Remark: Surface roughness enhances thin film evaporation when Π dominates but inhibits thin film evaporation when K dominates.

IMPACT: The developed model reveals a new regime where surface roughness inhibits thin film evaporation; this knowledge is critical for the design of surfaces to improve two-phase heat transfer.

PURDUE UNIVERSITY

Publication: H. Hu, J.A. Weibel, and S.V. Garimella, *Int J Heat Mass Transf,* 150 (2020) 119306.

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