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Theoretical calculation of work function for a sinusoidal surface[1]
JACQUELINE MALAYTER, ALLEN GARNER, Purdue University — Many micro- and nanoscale electrical phenomena depend critically on work function (WF), such as field emission and gas breakdown; however, characterizing WF variation due to surface roughness is challenging. Simple theoretical approaches assume the difference between effective (measured) and material WFs arise due to changes in capacitance as a scanning Kelvin probe (SKP) moves along a sinusoidal surface [1]. However, this simple theory neglects the spatial periodicity, which becomes critical as the SKP step size approaches the period. We extend this theory to specifically include periodicity. For a given ratio of surface roughness amplitude to the gap distance, increasing the period or reducing the SKP step size reduced the surface's effective WF. For an infinite period or infinitesimally small SKP step size, the effective WF approached the material WF. As the SKP step size approaches the period of the surface roughness, the effective WF approaches infinity. These results demonstrate the importance of accounting for surface waviness when measuring WF and in theories for field emission and microscale gas breakdown. [1] W.Li and D. Y. Li, J. Chem. Phys. 122, 064708 (2005). [2] A. L. Garner, A. M. Loveless, J. N. Dahal, and A. Venkattraman, IEEE Trans. Plasma Sci. 48, 808-824 (2020).

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