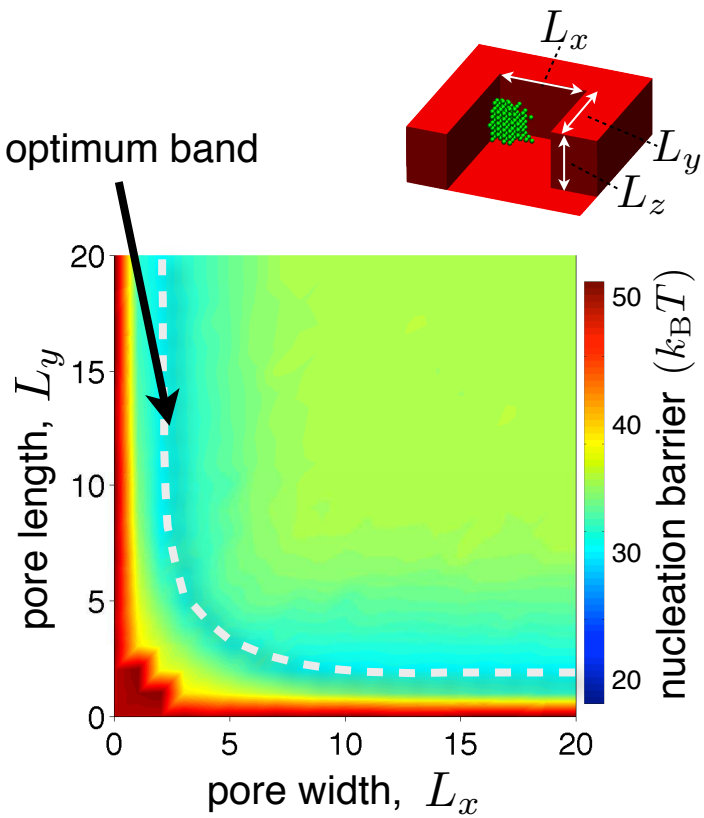
Patterning a surface so as to speed nucleation from solution



Free energy barrier to nucleation for cuboidal pores of fixed depth and variable aspect ratio Lx:Ly. The maximum nucleation rate is achieved when one of the two horizontal dimensions of a pore attains a critical length, hence the rate of nucleation is optimized along a band on the contour plot.

Scientific Achievement

Pores of well-chosen aspect ratio can dramatically speed nucleation relative to a planar surface made of the same material, while badly chosen pores provide no such enhancement.

Significance and Impact

Our results suggest simple design considerations for how to pattern a surface in order to best speed nucleation from solution. In addition, we also illustrate how the optimal pore size for nucleation is strongly influenced by thermodynamic conditions, suggesting that nucleation in porous materials will start in different locations depending on ambient conditions.

Research Details

We use simple statistical mechanical models to accurately compute free energy barriers to nucleation for a wide range of pores of varying aspect ratio. Our results allow us to determine the role of surface attraction and pore geometry and make predictions for how to best optimize the rate of nucleation.

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