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Optimal geometry for surface-enhanced diffusion

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Molecular diffusion in bulk liquids proceeds according to Fick's law, which stipulates that the current is proportional to the conductive area. This constrains the efficiency of filtration systems in which both selectivity and permeability are valued. Numerous studies have demonstrated that interactions between the diffusing species and solid boundaries, e.g., filter pore walls, can enhance or reduce particle transport relative to bulk conditions. To our knowledge, however, only cases that preserved the monotonic relationship between particle current and conductive area are known. Here, we provide examples of the opposite: a class of surface interactions that allows both the selectivity and permeability to increase several-fold as the pore size diminishes. The example is based on the century-old theory of a charged particle interacting with an electrical double layer. This surprising discovery could lead to improvements in the efficiency of filtration and may improve our understanding of biological pore structures. Authors: Anneline H. Christensen, Ankur Gupta, Guang Chen, Winfried S. Peters, Michael Knoblauch, Howard A. Stone, and Kaare H. Jensen.

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