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Nano-fluids at deep-sea hydrothermal vents

Ryuhei Nakamura*RIKEN*

Abstract

The conversion of ionic gradients into electrical energy is the basis of bioenergetics in modern cells. Similar processes have recently been envisioned for synthetic nanomaterials to harvest energy from salinity gradients, known as blue energy harvesting. These processes require intricate design of nano-fluidic devices, including confined and aligned nanochannel for selective ion transport. Here, we show the spontaneous formation of selective ion transport channels in a natural submarine alkaline hydrothermal vent (HV), allowing it to convert ionic gradients into electrical energy. This finding was based on the first detailed structural and functional analysis of natural alkaline HV materials. Spontaneous formation of ion channels discovered in this study has direct implications towards the origin of life on Earth and beyond. In particular, our study shows how osmotic energy conversion, a vital function in modern life, can occur abiotically in a geological setting. Additionally, the hierarchical alignments of nanomaterials produced in simple geological flow settings offer a geomimetic approach to create intricate self-assembled structures.