Single-layer MoS_2 nanopores as nanopower generators

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Making use of the osmotic pressure difference between fresh water and seawater is an attractive, renewable and clean way to generate power and is known as 'blue energy'[1]. Another electrokinetic phenomenon, called the streaming potential, occurs when an electrolyte is driven through narrow pores either by a pressure gradient[2] or by an osmotic potential resulting from a salt concentration gradient[3]. For this task, membranes made of two-dimensional materials are expected to be the most efficient, because water transport through a membrane scales inversely with membrane thickness[3-4]. Here we demonstrate the use of single-layer molybdenum disulfide (MoS_2) nanopores as osmotic nanopower generators. We observe a large, osmotically induced current produced from a salt gradient with an estimated power density of up to 10^6 watts per square meter - a current that can be attributed mainly to the atomically thin membrane of MoS_2. Low power requirements for nanoelectronic and optoelectric devices can be provided by a neighbouring nanogenerator that harvests energy from the local environment - for example, a piezoelectric zinc oxide nanowire array[5] or single-layer MoS_2. We use our MoS_2 nanopore generator to power a MoS_2 transistor, thus demonstrating a self-powered nanosystem.

References

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