COLLABORATIVE RESEARCH CENTER FOR NANOFLUIDICS AT NAZARBAYEV UNIVERSITY

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INTRODUCTION.

A significant engineering problem arises in the development of a novel solid-state air movement technology that brings high flux rates with lower parasitic power requirements in micro fuel cell systems. Current microelectronics fabrication processes for micro fuel cell systems are inadequate to provide high volumetric densities at attractive prices. More specifically, no viable solid-state air pumps can be easily integrated into microfabricated flow fields for fuel cells. Clearly needed are robust solid-state micropumps for air delivery that achieve cost effectiveness by removing the costly parts of typical motor-driven pumps. Special emphasis is placed on new physics that leverages unique nanoscale materials properties or novel approaches to move air.

MATERIALS AND METHODS.

A novel nanomechanical pump (nanopump) is desirable that will be capable of pumping gases and liquids at the nanoscale, through channels with diameters as small as 1–10 nm. Another significant problem is water desalination and purification. Fresh water is essential for our planet, particularly for water-scarce countries and for industrial use. Desalination of saline water (brackish water and seawater) has been considered as one of the most promising techniques because it can be applied to nearly any situation or location where saline water exists.

A new concept of fluid pumping through the carbon nanotubes (CNTs) was proposed in our papers a few years ago [1], and two patents were obtained in 2009 and 2010 [2]. We showed that significant atomic fluid flow in CNTs was activated by propagation of a Rayleigh traveling wave on the CNT surface. The CNT walls start pushing the gas, which begins flowing with high velocity in the direction of the wave. We called this new effect "nanopumping" [3,4].

RESULTS AND DISCUSSION.

Our preliminary experiments conducted at NURIS, ICP, KazSU and IMT have discovered two new physical effects consisting of i) a significant increase of the rate of liquid pumping through a micron scale tubes under ultrasound irradiation; and ii) a considerable amplification of the magnitude of surface waves where a bias potential was applied to the surface of a graphene film deposited on piezoelectric material [5].

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