DIRECT FABRICATION OF SUB-10 NM NANOPORES IN METAL OXIDE NANOSHEETS USING SWIFT HEAVY IONS

L.J. Xu[1], R.A. Rymzhanov[2,3], P.F. Zhai[1,4], S.X Zhang[1,4], P.P. Hu[1], X. Meng[5], J. Zeng[1,4], Y.M. Sun[1,4], J. Liu[1,4]

[1]*Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China, e-mail: xulj@impcas.ac.cn*

[2]*Joint Institute for Nuclear Research, Joliot-Curie 6, Dubna 141980, Russia,*

[3]*The Institute of Nuclear Physics, Ibragimov St. 1, Almaty 050032, Kazakhstan,*

[4]*School of Nuclear Science and Technology, University of Chinese Academy of Sciences, Beijing 100049, China,*

[5]*Electron Microscopy Centre of Lanzhou University, Lanzhou University, Lanzhou, 730000, China*

The solid-state nanopore has attracted much attention in the fields of single molecule detection, nanofluidic device and nanofiltration membranes. Many methods of solid-state nanopore fabrication have been discovered, among which the focused electron/ion-beam is perhaps the most commonly used approach to fabricate the sub-10 nm range, as the pore size and shape can be tuned by controlling the beam spot size, dwell time and position on the membrane [1, 2]. However, this method usually spends significant time and effort to create one nanopore, and which is also difficult to formation multiple nanopores at the same time. Here, we demonstrate a new method to directly fabricate size- and density-controllable sub-10 nm nanopores in metal oxide nanosheets (WO_3 and MnO_2) using swift heavy ions (SHIs) without any chemical etching process [3]. The size and creation efficiency of nanopores can be tuned by changing electronic energy loss S_e (Figure 1).

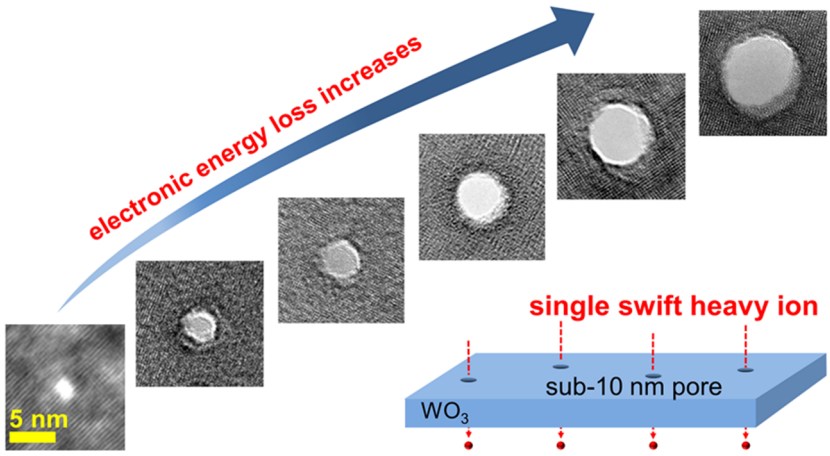

Fig. 1 Schematic diagram of nanopore formation in WO_3 nanosheets induced by SHIs

Based on the results of the thickness mapping of energy-filtered transmission electron microscopy, we found that the formation of nanopores in materials is closely related to its thickness. At the micro characteristic level, combined with molecular dynamics simulations, we propose that the nature of transient molten phase caused by SHI, such as viscosity and surface tension, are the key factors for the formation of nanopores. This method paves a way to fabricate solid-state nanopores in the materials with appropriate molten nature and thickness.

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