Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Proton permeation through atomically thin crystals ARTEM MISHCHENKO, School of Physics & Astronomy, University of Manchester, Manchester, M13 9PL, UK, SHENG HU, Manchester Centre for Mesoscience & Nanotechnology, Manchester M13 9PL, UK, MARCELO LOZADA, School of Physics & Astronomy, University of Manchester, Manchester, M13 9PL, UK, FRED SCHEDIN, Manchester Centre for Mesoscience & Nanotechnology, Manchester M13 9PL, UK, RAHUL RAVEENDRAN NAIR, School of Physics & Astronomy, University of Manchester, Manchester, M13 9PL, UK, ERNIE HILL, Manchester Centre for Mesoscience & Nanotechnology, Manchester M13 9PL, UK, IRINA GRIGORIEVA, ANDRE GEIM, School of Physics & Astronomy, University of Manchester, Manchester, M13 9PL, UK — It is well known that electrons can easily traverse through thin 2D crystals, including graphene, hexagonal boron nitride (hBN), molybdenum disulphide (MoS_2) etc.; at the same time pristine graphene and other 2D materials are impermeable to molecules and atoms including helium. Protons represent somewhat intermediate case, which, together with the fact that hydrogen technologies are extremely important nowadays, motivated us to study proton permeation through thin 2D crystals. Employing both liquid and solid proton conducting electrolytes we demonstrate that monolayers of graphene and hBN are permeable to protons at ambient conditions, while MoS_2, bilayer graphene and multilayer hBN show no proton conduction. Temperature dependence confirms the thermionic nature of the proton permeation with the activation energies of 0.3, 0.6 and 0.8 eV for monolayer hBN, monolayer graphene and bilayer hBN, respectively. Our findings suggest that atomically thin crystals can be promising for various hydrogen technologies, for instance, as proton exchange membranes for fuel cells.

Artem Mishchenko
School of Physics & Astronomy, University of Manchester,
Manchester, M13 9PL, UK

Date submitted: 12 Nov 2014 Electronic form version 1.4