

Supplementary Information

Descriptions of the etching procedure and preparation of the samples.

The etching reagent was prepared by stirring 1.0 g potassium permanganate in a solution mixture of 95 ml sulphuric acid (95-97%) and 48 ml orthophosphoric acid (85%). The filled resins were immersed into the fresh etching reagent at room temperature and held under agitation for 36 hours. Subsequent washings were done using a cold mixture of 2 parts by volume of concentrated sulphuric acid and 7 parts of water. Afterwards the samples were washed again with 30% aqueous hydrogen peroxide to remove any manganese dioxide. The samples were finally washed with distilled water and kept under vacuum for 5 days. The nanofilled sample sections were placed on a carbon tab previously stuck to an aluminum stub (Agar Scientific, Stansted, UK). The samples were covered with a 250-Å-thick gold film using a sputter coater (Agar mod. 108 A).

Description of the sample preparation for the tests on the water transport properties.

The thickness of the water absorption test samples was made small, deliberately, compared to its width and length, such as edge effects can be ignored and simple one-dimensional diffusion model analysis can be applied without incurring significant error. The specimens were placed into distilled water chambers maintained at constant temperatures of 25°C. The specimens were weighed periodically using a digital balance with 0.01 mg resolution to determine the percent weight change, and, thus, water uptake.

The specimens were periodically removed, dried and immediately weighed, and then returned to the water bath. The drying step was performed to ensure the removal of excessive surface (superficial) water, specimens were gently wiped dry using clean, lint-free tissue paper.

Equipment and experimental procedure for the electrical measurements.

The samples were coated by employing a silver paint with a thickness of about 50 μm and a surface resistivity of 0.001 Ω·cm in order to reduce the contact resistance and their eventual surface roughness. The measurement system, remotely controlled by the software LABVIEW®, is composed of a suitable shielded cell with temperature control, of multimeter Keithley 6517A with function of voltage generator (max ±1000V) and voltmeter (max ± 200 V) and the ammeter HP34401A (min current 0.1μA) for samples above the percolation threshold. For ones below the percolation threshold the system is composed only of multimeter Keithley 6517A with function of voltage generator (max ±1000V) and pico-ammeter (min current 0.1fA). For sensitivity purposes the applied electric field has been 0.5 MV/m for samples below the percolation threshold, whereas

in order to avoid Joule heating of samples it has been set to 5.0 kV/m for samples above the percolation threshold.

Impedance measurements were carried out in the frequency range [0.1-1000] kHz by using a Quadtec7600 LCR meter (0.05% Slow Measurement Accuracy) and by applying a sinusoidal voltage stress of amplitude 0.1V or 1V for the sample above or below the EPT respectively, in order to avoid measurements around the current saturation limit (100mA) of the instrument for the samples with low resistivity.