APPLICATION NOTE

Manipulation of Mixed Ionic and Electronic Ceramic Nanofibers

Solid oxide electrolysis and fuel cells (SOEC/SOFC) are promising clean energy conversion technologies. One of the approaches pursued to optimize the design of SOEC/SOFC is to use electrospun nanofibers made of solid oxides (SO). Some of the SOs are mixed ionic and electronic conductors (MIEC), so understanding their charge carrier dynamics in detail is important for cell design. To better understand the functionality of MIEC nanofibers, we study structural and electrochemical properties of electrospun ceramic nanofibers using combined electrochemical measurements and transmission electron microscopy (TEM).

Electrochemical measurements inside the TEM require a precise placement of a nanofiber on a chip. The challenge is that the nanofibers charge in the presence of electron beam, so they constantly move and change orientation during sample preparation. In this application note, we show how to reliably manipulate Gd-doped ceria nanofibers via in-situ SEM using Imina Technologies nanoprobers.

We used Imina Technologies' in-situ nanomanipulator inside a scanning electron microscope (SEM), which was equipped with a gas injection system (GIS) for depositing a conductive material, and a focused ion beam (FIB) for cutting.

A single MIEC nanofiber (Figure 1) of ca. 15 µm in length was separated from a sheet of electrospun nanofibers and attached to the 100 nm nanoprober tips by Pt deposition. The nanofiber was then detached from one of the probe tips and transferred to a commercial microelectromechanical system (MEMS) chip on top of the viewing window between two 4 µm biasing electrodes, about 5 µm apart (Figure 2). Afterwards, the nanofiber was electrically connected by Pt deposition. For the deposition, a gas injection system directed Pt gas precursor to the end of a nanowire, and the electron beam broke down the precursor, leaving only the Pt-rich component in the deposition area.

Using two miBot nanoprobers with adjustable speed, the MIEC nanofiber could be precisely placed on the MEMS chip. This approach allowed us to prepare the sample for further electrochemical examination inside TEM.

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Experiment performed in and in collaboration with:
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Imina Technologies products in use:
NANO Produt Line

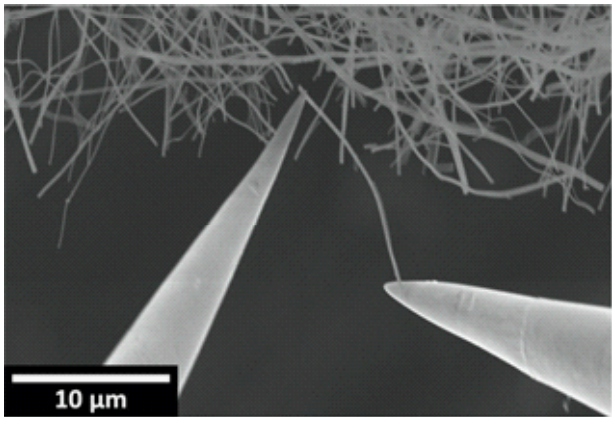

Figure 1. Separation of a single nanofiber from the nanofiber sheet using two nanoprober tips.

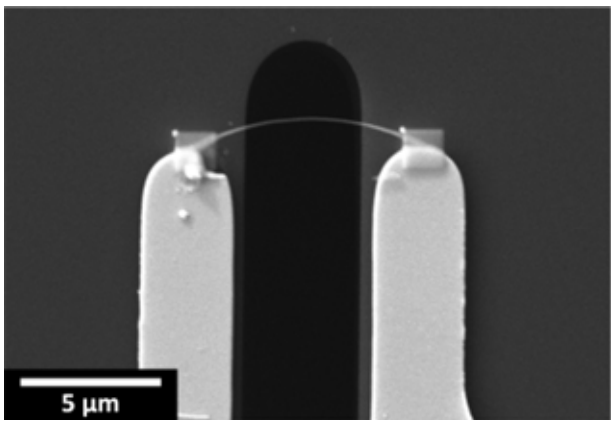

Figure 2. MIEC nanofiber, placed and prepositioned on the MEMS chip using the nanoprobers, is electronically connected to the biasing electrodes with deposited Pt.

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