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Exploring the Deeper Layers of Fuel Cells with Transmission Electron Microscopy

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Reversible fuel cells are currently an active area of research for power generation and storage [1], [2]. These devices are meant to be coupled with other sources of power generation such as photovoltaic devices or wind turbines and can be run reversibly as a power storage unit when excess power is generated and as a power supply when there is a deficiency of power. The morphology of gas diffusion electrode (GDE) [3], a component of these devices, significantly affects the performance of the device. Electron microscopy has been employed in the past to understand the morphology of these components. GDEs have to be conductive to allow electrons to pass through and porous for gas/liquid to diffuse through and allow for the chemical reaction to take place. One material that has great potential for use as an electrode is carbon paper.

This carbon paper is composed of several layers of fibers oriented in different directions. For the chemical reaction to occur within a desired time range, these fibers have to be coated with a catalyst (metal oxide alloys, in this case). It is important that all the fibers are coated completely with this catalyst in order to increase the surface area of catalyst contact without compromising the porosity of the electrode. So far, Scanning Electron microscope images from these samples have shown that the desired coating of the catalyst on the top most layers of the electrode has been achieved (Fig. 1, Fig. 2, Fig. 3). Due to the thickness of the sample, SEM is not suitable to characterize the deeper layers within the fibers.

With appropriate sample preparation, such as microtoming the embedded fibres, Transmission Electron Microscopy (TEM) must be used to characterize these GDEs to determine if the catalyst coating is uniform through all the layers. Further the other research interest is to determine the crystal sizes of the catalyst being deposited on these fibers. The resolution and analytical capability of the TEM makes it the critical instrument to explore the morphology and composition material [4].

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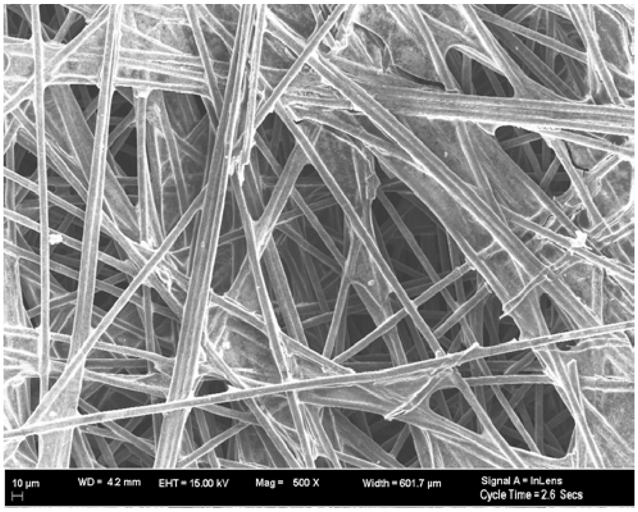

Figure 1: SEM image of carbon paper coated with catalyst.

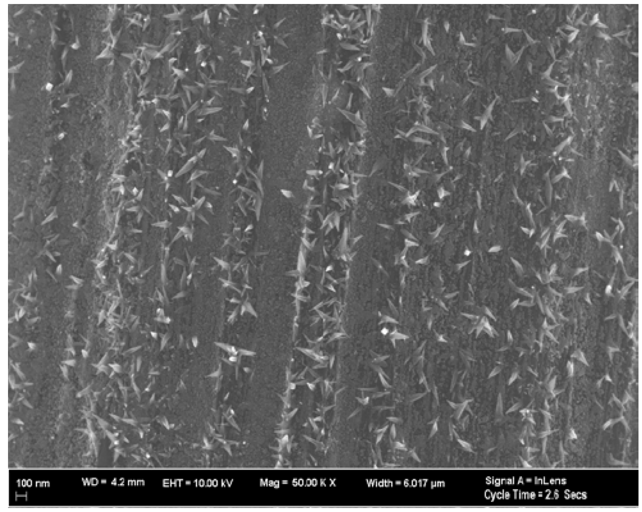

Figure 2: SEM image showing catalyst crystals on a single fiber.

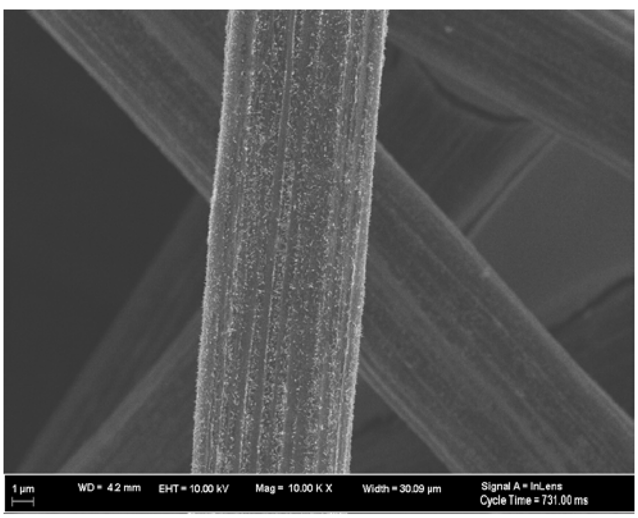

Figure 3: SEM image of a fiber coated with catalyst. From this SEM image we are not able to assess how well the fibers deeper in the sample are coated.

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