# NiZn/C Electrocatalysts for Direct Hydrazine Anionic Fuel Cells

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Promising results on the development of direct liquid-feed fuel cells based on hydrazine hydrate as a fuel have been reported by Daihatsu Motor Co. Ni-based anode catalysts when tested in single MEA fuel cells have demonstrated performances similar to that of a $H_2/O_2$ PEM fuel cell[1,2]. When compared to other liquid fuels such as alcohols, hydrazine hydrate electrooxidation does not produce greenhouse gases and the employed anode electrocatalysts are not poisoned. Furthermore, the utilization of inexpensive and abundant electrocatalysts for both anode and cathode electrodes will make fuel cell technology more affordable.

The study presented here aims at the further improvement of NiZn anode electrocatalysts by the decrease of the catalyst particle size and the addition of a conductive support such as carbon. Synthesis of electrocatalysts was performed through various methods including wet impregnation and ball milling. The ratio of Ni to Zn was kept at 87:13 as it was previously reported that this composition resulted in significant improved performance over pure Ni[3]. On the other hand, metal to carbon loading was varied from 20% to 60% onto commercially available Vulcan XC-72R and Ketjenblack EC-600JD carbons.

Physical characterization of the synthesized electrocatalysts was performed via SEM, STEM, HRTEM, and XRD. Figures 1 and 2 display SEM micrographs of 40wt% $Ni_{0.87}Zn_{0.13}$ supported on Ketjenblack synthesized by ball milling (Figure 1) and supported on Vulcan synthesized by wet impregnation (Figure 2). For both electrocatalysts, particle sizes range from 5 to 20 nm.

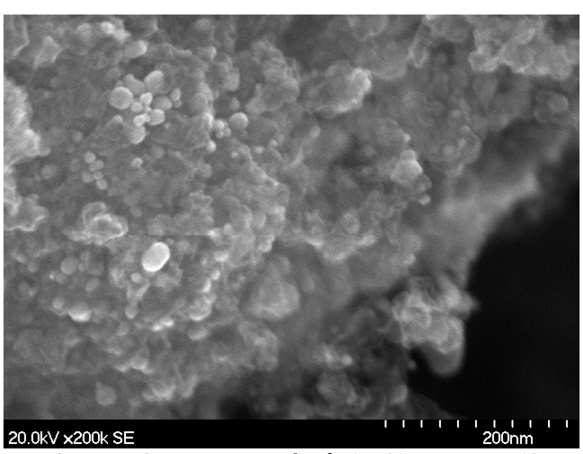

**Figure 1.** SEM micrograph of 40wt% $Ni_{0.87}Zn_{0.13}$/C (Ketjenblack EC-600JD) synthesized by ball milling.

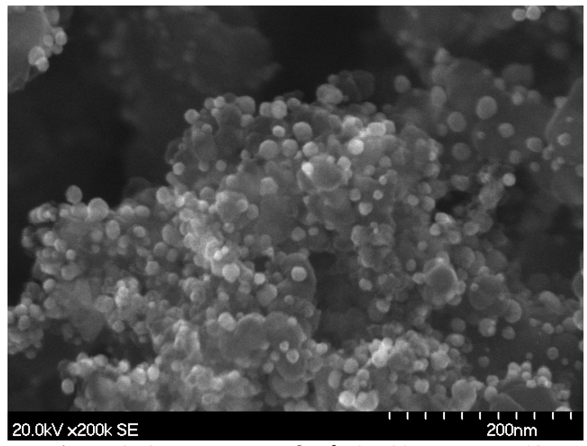

**Figure 2.** SEM micrograph of 40wt% $Ni_{0.87}Zn_{0.13}$/C (Vulcan XC-72R) synthesized by wet impregnation.

The electrochemical activity of the synthesized NiZn/C catalysts was assessed via rotating disc electrode (RDE) experiments. Figure 3 displays the RDE data for ball milled samples: 40wt% and 60wt% $Ni_{0.87}Zn_{0.13}$ supported on Ketjenblack; and wet impregnation samples: 40wt% and 60wt% supported on Vulcan. Supported electrocatalysts were compared to the high performing unsupported $Ni_{0.87}Zn_{0.13}$ electrocatalyst synthesized via spray pyrolysis from ref. 3.

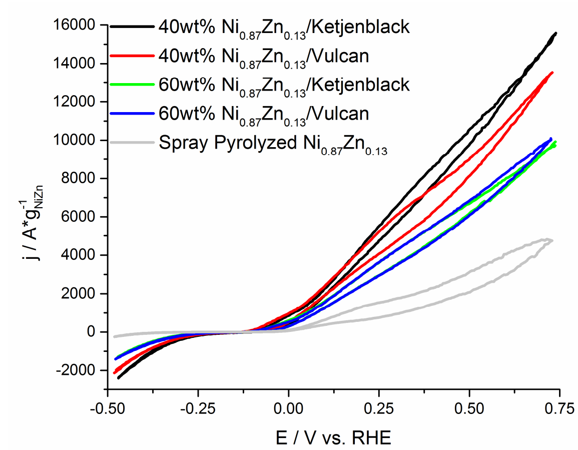

**Figure 3.** RDE data for the oxidation of hydrazine hydrate by $Ni_{0.87}Zn_{0.13}$/C electrocatalysts (1 M KOH, 60°C, 20 mV/s).

A significant improved performance, both in terms of onset potential and mass activity, was observed from supported $Ni_{0.87}Zn_{0.13}$/C electrocatalysts. Further studies including particle size dependence as well as *in situ* infrared spectroelectrochemical studies will be performed to better understand the effect of particle size and the inclusion of a conductive matrix as support on the observed improved performance. Additionally, evaluation of these electrocatalysts integrated into single MEA fuel cells and studies of their selectivity for the electrooxidation of hydrazine hydrate will be performed to assess their viability as anode catalysts for direct hydrazine anionic fuel cells.

**References:**

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