In view of these facts, we here report the synthesis and properties of novel SnO$_2$ nanostructure, respectively. The unique properties such as high specific surface area can provide easy diffusion path lengths for substrates to access, leading to faster kinetics. Moreover, the deactivation of Sn metal electrodes in CO$_2$ reduction was found to be fast, especially in aqueous solutions. With respect to these, developing new material synthesis technology to give innovative new catalysts with optimal performance is the priority.

In the effort to improve catalytic activity and stability, two important aspects of catalyst materials have to be improved, which are the composite materials and nanostructure, respectively. The unique properties such as high specific surface area can provide easy diffusion path lengths for substrates to access, leading to faster kinetics. In view of these facts, we here report the synthesis and properties of novel SnO$_2$-CuO nanocomposites, and their catalytic activity toward CO$_2$ electroreduction are investigated.

SnO$_2$-CuO nanocomposite was prepared by co-precipitating Cupric chloride dehydrate (CuCl$_2$·2H$_2$O) and Stannous chloride dehydrate (SnCl$_2$·2H$_2$O) atAmmonium Hydroxide atmosphere, which was then annealed in the air at 500°C for 6 hours. This catalyst with an average diameter of about 400 nm (Fig. 1) was then sprayed on the gas diffusion layer to compose a working electrode. The results of characterizations using SEM and XRD techniques are discussed, along with their implications to the exploration of the nanoparticles as CO$_2$ reduction catalysts. The kinetics and electrocatalytic activity of the SnO$_2$-CuO nanocomposites/GDL electrode was measured using cyclic voltammetry (CV) and linear sweep voltammetry (LSV).

Figure 1 shows the SEM image of SnO$_2$-CuO nanocomposites. It is obvious that these SnO$_2$-CuO nanocomposites with a diameter about 400 nm provide a high surface area which can play a promoting role in catalysis of reducing CO$_2$ to HCOOH. The positive effect of this nanocomposite structure can be verified in Figure 2.

Figure 2 displays the current-potential curves in both N$_2$ and CO$_2$-saturated aqueous solutions. The curve under N$_2$ has the same trend with the curve under CO$_2$; however, the onset potential, when the current density exceeds 0.35 mA cm$^{-2}$, appeared at -0.4V under CO$_2$ which is slightly higher than such onset potential under N$_2$ which may be caused by the competition at electrode between hydrogen evolution and CO$_2$ reduction and this onset potential is about 300mV higher than Prakash’s report. The large difference in performances of the resultant nanocomposite SnO$_2$-CuO/GDL electrode may be attributed to the fact that the nanocomposite SnO$_2$-CuO offers a positive function in CO$_2$ reduction.

References


Figure 1: SEM image of SnO$_2$-CuO nanocomposite.

Figure 2: CV curves of SnO$_2$-CuO nanocomposite supported on GDL in N$_2$ and CO$_2$-saturated 0.5M KHCO$_3$ solution at scan rate 50mV / S. Electrode area 4.0 cm$^2$. Catalyst loading: 1mg cm$^{-2}$.