Fabrication of copper nanowire using NIL for electroreduction of carbon dioxide

Yangchun Lan, Yang Jiang and Dehu Cui
Department of Electrical and Computer Engineering, Southern University of Science and Technology, Shenzhen, China

The excessive utilization of fossil fuels provoked the increasing energy crisis and the worsening global climate, which triggered tremendous attention at carbon dioxide capture, storage and utilization. To address these issues, electrocatalytic reduction of carbon dioxide into hydrocarbon fuels is considered as a promising strategy, among which metal electrodes, benefiting from high electronic conductivity, show considerable catalytic activities toward carbon dioxide electroreduction[1-3]. Especially, copper metal is the only known material capable of catalyzing the formation of significant amounts of hydrocarbons at high reaction rates over sustained periods of time [4]. However, the practical applications of metal electrodes are greatly impeded by the very low energetic efficiencies, which could be primarily ascribed to their extremely low amount of catalytically active sites. Over the past three decades, researchers have evaluated lots of metal nanoparticles as catalysis for electroredcution of carbon dioxide. While the morphology of metal nanoparticles was hard to be controlled, it could affect the surface area and active sites of catalysis. Now we investigated electroreduction of carbon dioxide by copper nanowire, which was gained by using the nanoimprint lithography (NIL).

The electrical properties of the aligned-copper stripes are highly dependent on the stripe configuration, mainly the direction and connectivity of individual copper nanowires inside the stripe. Figure 1 shows the schematic of shape accessible pattern can be fabricated through regular NIL process on ITO glass substrate by using PMMA as resist. Second, copper arrays are partially filled by established solution-based methods for synthesis of Cu nanowire. After move the PMMA residual layer, finally, we can get the shape controlled copper nanowire, which is very beneficial for electroreduction of carbon dioxide [Figure 2].

[1] Lei F., Liu W., Sun Y., Xu J., Liu K., Liang L., Yao T., Pan B., Wei S., Xie Y., Metallic tin quantum sheets confined in grapheme toward high-efficiency carbon dioxide electroreduction, Nature Comm., 2016, 7, 12697.
[2] Li C.W., Ciston J., Kanan, M.W., Electroreduction of carbon monoxide to liquid fuel on oxide-derived nanocrystalline copper. Nature, 2014, 508, 504.
[3]. Gao, S. Lin Y., Jiao X., Sun Y., Luo Q., Zhang W., Li D., Yang J., Xie Y., Partially oxidized atomic cobalt layers for carbon dioxide electroreduction to liquid fuel, Nature, 2016, 529, 68.
[4] Kuhl K.P., Cave E.R., Abram D.N., Jaramillo T.F., New insights into the electrochemical reduction of carbon dioxide on metallic copper surfaces., Energy Environ. Sci., 2012, 5, 7050.

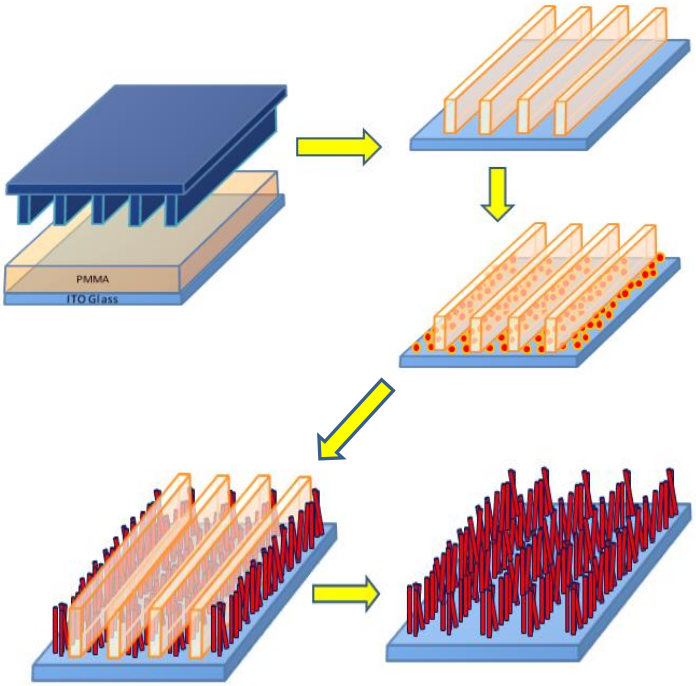

Figure 1. Fabrication process of copper nanowire using NIL.

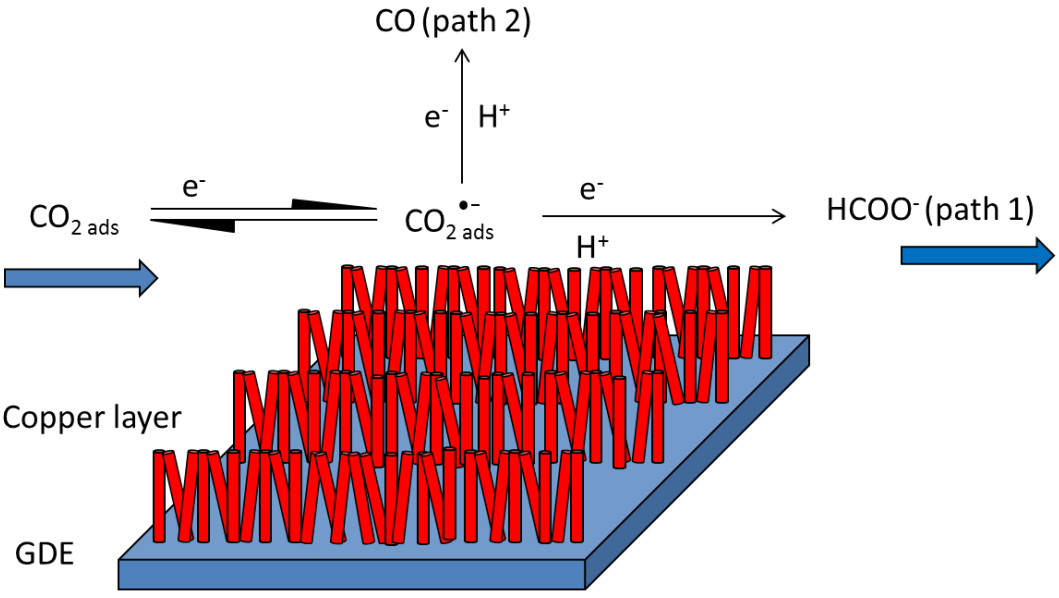

Figure 2. The pathway of electroreduction of carbon dioxide was on copper nanowires.