Copper-based coatings on polylactic acid for electrocatalytic CO_2 reduction

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The climate crisis caused by global warming is recognized by the United Nations (UN) as a trigger for catastrophic effects such as weather extremes and natural disasters. Carbon dioxide (CO_2) emissions constitute about three-quarters of the total greenhouse gases (GHG) released and have gathered global attention due to their significant contribution to global warming.

Developing new catalytic processes can accelerate the transition to a more sustainable Earth. Electrocatalytic methods are the most promising of all the catalytic processes because they are energy efficient, selective, easy to control, and flexible. They are also known as the most viable solution for the CO_2 reduction reaction (CO_2RR).

Metallic copper has notable electrical conductivity, making it suitable for many electrode-based applications. Additionally, copper-based materials were reported to be active and selective electrocatalysts capable of producing hydrocarbons from the CO_2RR. However, the updated version of the Element Scarcity—EuChemS Periodic Table by the European Chemical Society brings attention to the limited abundance of copper. Ensuring a sustained supply of this element is a significant challenge. Utilizing thin film coatings to produce electrodes is a potentially practical approach to mitigating element shortages. Furthermore, Cu-based electrodes using a polymeric skeleton can provide several benefits concerning cost, material accessibility, and weight.

This work used Polylactic acid, PLA, as the substrate for Cu-based electrodes. PLA is widely used in additive manufacturing, a low-cost technique that enables the fabrication of 3D structured electrodes. Magnetron sputtering (PVD technique) was applied to develop copper metallic surfaces on PLA. Different coatings having Cu/CuO_x/Cu layers were produced. Anodization was a secondary technique applied to enhance electrochemical active surface area. The CuO_x in the middle of the coating might act as a barrier material to stop the oxidation reaction during the anodization process while maintaining film adhesion (Fig. 1). Chemical and morphological characterization of the resulting films will be discussed, as well as the electrochemical properties for CO_2RR applications.

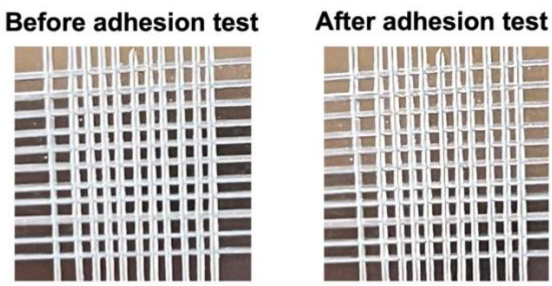

Fig.1. Adhesion measurement according D3359–17 standard procedure.