CO_2 reduction to nanocarbons with controlled morphology and high specific capacitance

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Abstract
The climate warming is no longer a hypothesis or a theory, it is an actually happening phenomenon. Although the debates on its causes, scale and consequences still take place, the majority of scientists agree that human activities, and specifically human-induced emissions of heat-trapping greenhouse gases including CO_2, are among the major drivers of current climate disturbances [1]. To overcome the problem, different CO_2 capture, storage and conversion techniques were recently established. Among the latter ones, the electrochemical CO_2 conversion, particularly with the usage of molten salt electrolytes [2–5], attracts considerable attention. The present study concerns the electrochemical conversion of greenhouse gas CO_2 to solid nanocarbons in low temperature (500◦C) eutectic mixture of Li–K–Na carbonates. The emphasis is made on the effect of electrode material on the morphology of the obtained nanocarbons. Three different materials such as Ni, Cu and NiCu alloy were chosen for anode while galvanized Fe was employed as cathode. The XRD analysis and Raman spectroscopy showed that the produced nanocarbons are in general amorphous. They possess high specific surface area (SSA) in the range of 400–520 m^2/g and high pore volume of 0.8–1.3 cm^3/g. The SEM and TEM evidenced that the usage of Ni anode resulted in the development of honeycomb carbon nanostructures while Cu and NiCu anodes stimulated the growth of unusual scroll-like tubular morphologies which in the case of Cu anode form sea urchin-like assemblies. This is unexpected result since it is not supported by the traditional nucleation growth process of tubules at the applied temperature. A new formation mechanism of such scrolled tubules is proposed where the crucial role is ascribed to CuO nanostructures in the role of templates originating from the corroded anodes. The presence of tubular nanostructures can be the explanation of the higher SSA and pore volume in the samples prepared with Cu and NiCu anodes. Remarkably, the value-added tubular-like carbon nanostructures can be produced in a low temperature electrolytic CO_2 conversion process even at 500◦C which at the same time contributes to the reduction of CO_2 footprint.

References

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Figures

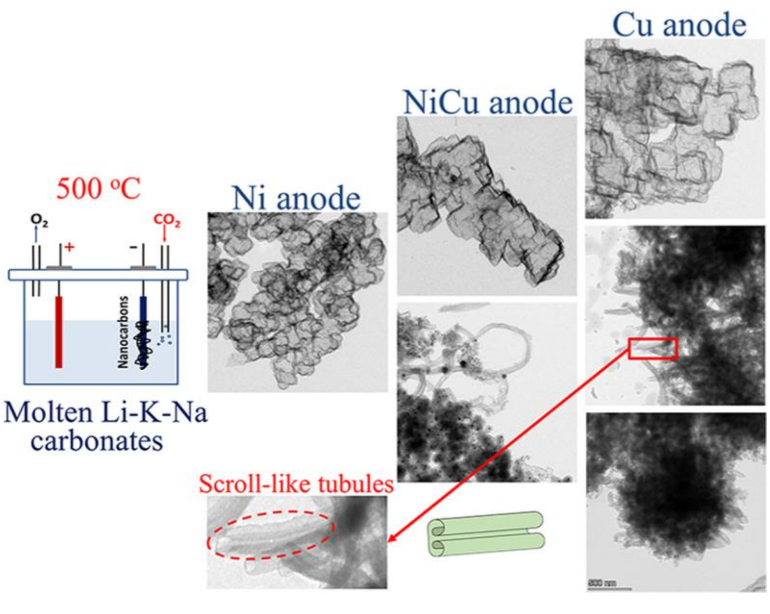

Figure 1: Carbon nanostructures with various morphologies produced using Ni, NiCu and Cu anodes.