Conversion of CO_2 to High Added Value Nanocarbons

C. Trapalis*, N. Plakantonaki, M. Vagenas, T. Giannakopoulou, N. Todorova

Institute of Nanoscience & Nanotechnology, NCSR "Demokritos", Agia Paraskevi, 15341, Greece
*c.trapalis@inn.demokritos.gr

Abstract

Nowadays, decrease of carbon dioxide (CO_2) concentration in the atmosphere throught carbon capture and conversion processes, is a key player in reducing climate change issues since it can positively impact the total levels of greenhouse gases[1]. At the same time, preparation of advanced nanocarbons like graphene, CNTs, CNFs, and their composites through effective environmentally benign procedures remains in the focus of intensive research[2, 3]. In the present work, a simple scalable method for conversion of the greenhouse gas CO_2, to high added value nanocarbons with controled morphology is described. Molten salt electrochemical systems consisting of eutectic mixtures of alkaline carbonates (Li, Li–K, Li-K-Na) as electrolytes, Ni-Cu or galvanized iron (Fe) electrode as cathode and, Ni-Cr electrode as anode, were applied for the conversion of CO_2 to nanocarbons using electrolysis. During molten-salt electrolysis, CO_2 was flow throw the electrolyte, and carbons with various marphologies were deposited on the cathode. The produced nanocarbons were washed with HCl, dryied at vacuum oven and activated under CO_2 gas flow at high temperature. The structure and the morphology of the prepared materiasl were examined employing X-ray diffraction analysis, scanning electron microscopy, nitrogen porosimetry and electrochemical characterization.

It was demonstrated that tuning the nanocarbons morphology can be achieved by regulating the electrolyte composition and electrolysis parameters. In pure Li_2CO_3 electrolyte, carbon nanofibers (CNFs) were synthesized at 790°C. Nanocarbons with different morphologies (lamellar, vertical oriented, sheet-like) were obtained in Li-K at 600~650°C. Amorphous carbon with irregular shaped morphology obtained in Li-Na-K at 600°C, while honeycomb carbon generated in Li-Na-K at 500°C.

Activated carbon exhibited outstanding electrochemical performance ascribed to its high specific surface area (1020 m^2/g) compared with non-activated one. The porosity and the cyclic voltammetry, charge-discharge and impedance measurements evidenced that the prepared nanocarbons can be used for energy storage, while the suggested environmentally benign preparation method can be scaled up to industrial extent due to simplicity.

References

[1] P. Williamson, Nature, 530, (2016), 153–155.
[2] X. Liu, X. Wang, G. Licht, S., J. CO_2 Util., 36 (2020) 288–294.
[3] S. Licht, X. Liu, G. Licht, X. Wang, A. Swesi, Y. Chan, Mater. Today Sustain. 6 (2019) 100023.

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