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Tunable and Simple Fabrication of CuO/Nitrogen Functionalized Graphitic-Rod Electrode via Electrochemical Deposition

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This study aims to develop a new method for capacitive improvement of 2 black (2B) (74% graphite, 20% clay and 5% wax; diameter 2.0 mm [1]) pencil graphitic rod through nitric acid treatment followed by CuO deposition via electrochemistry. After acid treatment, oxygen- and nitrogen- containing species were generated on the PR surface, which confirms by x-ray photoelectron spectroscopy (XPS), Fourier transform infrared spectroscopy (FT-IR), and the presence of redox peaks in cyclic voltammogram (CV) measured in 0.5 M Na2SO4 electrolyte with a scan rate of 10 mV/s. This causes an increasing in areal capacitance (Ca) from 3 mF/cm2 (original PR) to 76 mF/cm2. Subsequently, electrochemical deposition of CuO was performed via two conditions, at potential of 0.4 V (for electrolyte pH 10) and 0.9 V (for electrolyte pH 9) in ammonia solution system. N1s spectra indicate the presence of pyridinic (-N=C-) and pyrrolic (-CH-NH-) nitrogen on the samples prepared from both conditions. A mixture of CuO and Cu(OH)2 was observed in all samples. However, the electrode prepared at 0.4 V shows higher CuO content than that prepared from 0.9 V. This results in different redox peaks and Ca values, where the electrode prepared at 0.4 V provides higher Ca (170 mF/cm2) than that prepared at 0.9 V (88 mF/cm2). It can be concluded that the presence of oxygen species, pyridinic and pyrrolic nitrogen, and high CuO content play an important role in capacitive enhancement for supercapacitor application and they can be easily altered using our developed method.

Primary author: Ms KATAVUT, Chanita (Department of Chemical Engineering, Faculty of Engineering, Thammasat University, Pathunmthani 12120, Thailand)

Co-authors: Ms VIBOONRATANASRI, Duangkamon (National Nanotechnology Center (NANOTEC), NSTDA, 111 Thailand Science Park Phahonyothin Road Khlong Nueng, Khlong Luang, Pathumthani, 12120, Thailand); Ms VAYACHUTA, Lapporn (National Nanotechnology Center (NANOTEC), NSTDA, 111 Thailand Science Park Phahonyothin Road Khlong Nueng, Khlong Luang, Pathumthani, 12120, Thailand); Mr GRISDANURAK, Nurak (Center of Excellence in Environmental Catalysis and Adsorption, Thammasat University, Pathumthani 12120, Thailand, Department of Chemical Engineering, Faculty of Engineering, Thammasat University, Pathunmthani 12120, Thailand); Ms PROMPINIT, Panida (National Nanotechnology Center (NANOTEC), NSTDA, 111 Thailand Science Park Phahonyothin Road Khlong Nueng, Khlong Luang, Pathumthani, 12120, Thailand)

Presenter: Ms KATAVUT, Chanita (Department of Chemical Engineering, Faculty of Engineering, Thammasat University, Pathunmthani 12120, Thailand)

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