Seminar

==========

Institute for Plasma Research

==========

Title: Carbon-based Nanomaterials for Applications in Energy Generation & Storage

Speaker: Dr. Amba Sankar K N
PSG College of Arts and Science, Coimbatore

Date: 21st June 2024 (Friday)

Time: 03.30 PM

Venue: Seminar Hall, IPR

Abstract

Energy generation and storage are crucial for sustaining economic growth and environmental health.[1] In this study, we synthesized various carbon nanomaterials, including ball-milled graphite nanoparticles (BMG), graphene oxide (GO), reduced graphene oxide (RGO),[2] and carbon quantum dots (CQDs).[3] These materials were utilized in both energy generation and storage applications, specifically in organic photovoltaic devices and supercapacitors. Our objective was to determine which material offers superior performance in both applications.

In the context of energy generation, organic photovoltaic devices are fabricated with five layer thin film geometry. Our focus was on tuning the buffer layers and active layers. We used four different carbon nanomaterials (BMG, GO, RGO and CQDs) as the electron transport buffer layer in combination with a ZnO composite. Among these, RGO significantly improved electron mobility within the electron buffer layer of organic photovoltaic cells, increasing efficiency from 1.03 % to 1.59 %.[4] Further efficiency gains were achieved through post-heat treatment and optimization of the hole transport layer (MoO_3), ultimately reaching an efficiency of 2.38%.

In energy storage applications, we analyzed the same four carbon nanomaterials to evaluate their performance as supercapacitor electrodes. GO exhibited the highest specific capacitance (C_S) of 38.75 F/g, compared to BMG, RGO, and CQD, which had specific capacitance values of 3.84, 27.59, and 0.34 F/g, respectively.[5] Additionally, different MoO_3 polymorphs, such as *h*-MoO_3 and α-MoO_3, were synthesized and their specific capacitance performance was examined. Among these MoO_3 polymorphs, α-MoO_3 displayed a specific capacitance of 256 F/g. Subsequently, composites were created with various ratios of GO, including G25M75, G50M50, and G75M25. Among these composites, G50M50 achieved the highest specific capacitance of 450 F/g.

Reference

1. Panwar, N. L.; Kaushik, S. C.; Kothari, S., Role of renewable energy sources in environmental protection: A review. *Renewable and sustainable energy reviews* **2011,** *15* (3), 1513-1524.
2. Sankar, K. N. A.; Kumar, C. S.; Mohanta, K., Highly Stable Aqueous Dispersion of CTAB-Intercalated Reduced Graphene Oxide. *Materials Today: Proceedings* **2019,** *18*, 759-764.
3. Ambasankar, K. N.; Bhattacharjee, L.; Jat, S. K.; Bhattacharjee, R. R.; Mohanta, K., Study of Electrical Charge Storage in Polymer-Carbon Quantum Dot Composite. *ChemistrySelect* **2017,** *2* (15), 4241-4247.
4. Sankar, K. N.; Nandakumar, P.; Mohanta, K. In *Tunable the buffer layers of solution processed inverted P3HT: PC61BM solar cell*, 2024; AIP Publishing.
5. Nandakumar, P.; Sankar, K. N. A.; Ganesh, A. S.; Anandh, B. A.; Deepa, R., Electrochemical Performance of Carbon Materials. *Oriental Journal of Chemistry* **2022,** *38* (3), 604.