TUNING THE ELECTRICAL PROPERTIES OF MULTI-FLAKE REDUCED GRAPHENE OXIDE (RGO) FILMS VIA HIGH-VACUUM THERMAL REDUCTION

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Over the last decade, graphene devices have been a central focus of academic research. Sensors, biosensors, field-effect transistors, varactors, and other devices have already been extensively studied in the literature(1–3), yielding relevant information regarding the electronic transport, electrical properties, and structural properties of the material. However, the high cost associated with graphene production remains a central barrier to the commercial application of these devices. In this regard, an alternative approach, primarily for sensor and biosensor applications, is the utilization of graphene-like materials, such as reduced graphene oxide (rGO). This 2D material possesses a structure similar to graphene, with carbon atoms arranged in a hexagonal honeycomb lattice along with residual oxygenated groups. This grants it electrical properties similar to graphene while offering the advantage of being processed in the liquid phase. Nevertheless, since rGO is obtained through the reduction of graphene oxide, it lacks a defined stoichiometry (4). Consequently, it is common to analyze only properties such as conductivity to identify the best material for electronic applications, often neglecting the possibility of modulating the material's electrical properties to optimize specific applications. This way, in this study, the electrical properties of rGO were investigated as a function of the carbon sp2/sp3 ratio, making it possible to associate conductivity, electronic mobility, stability, and capacitance with the material's degree of reduction. The carbon sp2/sp3 ratio was adjusted via high-vacuum thermal reduction at temperatures ranging from 350°C to 500°C. Electrolyte-gated transistors were utilized as the study platform; from the transfer curves, it was possible to determine electronic mobility, conductivity, and film stability. Furthermore, by short-circuiting the source and drain electrodes, the device was operated as a MIS capacitor, where the gate acts as the metal, the electrolyte as the insulator, and the rGO as the semiconductor, thereby providing information regarding the capacitance and impedance of the material. Through this approach, it was possible to correlate structural information obtained via XPS and Raman spectroscopy with the electrical properties of the material, enabling a better interpretation of device operation and supporting future applications in sensing and biosensing.

References

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Palavras-chave: reduced graphene oxide; electrical properties; 2d materials.