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Cyclic Voltammetry Study of $DMAPbI_3$ Perovskite Material

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In the last decade, the most investigated perovskite materials are the hybrid organic-inorganic perovskites (HOIPs) due to their optoelectronic properties and possible application in production of photovoltaics. As a result, there is a continuous ongoing search for new ones, but also a thorough investigation of the properties of already known HOIPs. Here we present the cyclic voltammetry study of dimethylammonium lead iodide ($DMAPbI_3$).

A slightly modified synthesis of $DMAPbI_3$ than the one described in the literature was performed. Stoichiometric amounts of lead iodide (PbI_2) and dimethylammonium iodide (DMAI) were dissolved in acetonitrile, followed by temperature-controlled evaporation at 60 °C. This lead to the formation of $DMAPbI_3$ yellow crystalline powder. The identification and purity of the obtained compound was confirmed by PXRD, vibrational spectroscopy, and SEM/EDX analysis.

Cyclic voltammetry studies of $DMAPbI_3$ were conducted in dichloromethane (DCM) and tetrabutylammonium chloride (TBAC) as the electrolyte. A paraffin-impregnated graphite electrode (PIGE) was utilized as the working electrode, on which the perovskite microparticles were immobilized. The electrochemical activity of $DMAPbI_3$ is evident through an intense, wide, and irreversible anodic peak that initiates at -0.153 V. The voltammograms recorded with lower scan rates revealed that this peak is complex consisting the oxidation of $DMAPbI_3$constituents. The organic cation (DMA+) exhibits oxidation to various oxidation states, including the possibility of being oxidized to CO_2. The lead ion can undergo oxidation to form leadoxide, while the iodide ion can undergo oxidation to different oxidation numbers, but most probably to elemental iodine. However, the quantity of elemental iodine produced is minimal, making it difficult to detect. The observed vague and small reduction peak may be attributed to some of these by-products, rather than originating from the perovskite itself.

Keywords: dimethylammonium lead iodide, cyclic voltammetry, PXRD, vibrational spectroscopy, SEM/EDX