ILLUMINA: Interface-Engineered Lignin Luminescent UV-Responsive Multijunction Integrated Nodal Anode Architecture for Equatorial UV Photon Conversion

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ILLUMINA is a multilayer biomass-based film that has been created to assist homes and rural schools struggling with expensive lighting solutions by converting wavelengths and controlling optical transmission to provide a sustainable and low-priced solar solution. Multiple methods were used to generate and study multilayer structures of lignin chromophore thin films. XRD identified crystalline and amorphous domains, UV-Vis spectroscopy assessed absorption, and PL spectroscopy analyzed visible-light emission. SEM-EDX analysis revealed a consistent structure of multi-layers comprising carbon, nitrogen, and oxygen-based organic layers alongside conductive oxides of Sn, F, and In. XRD results confirmed the presence of crystalline SnO_2 and ITO, integrated with amorphous lignin and g-C_3N_4, indicating successful hybridization. UV-Vis results showed significant absorption in the UV and visible spectrum, and PL findings demonstrated effective re-emission in the visible range, confirming the material's wavelength-conversion capability. Lignin composition influenced all electrochemical parameters, where 10% lignin produced optimal CV currents and OCV, 5% lignin yielded the greatest chronoamperometric stability, and 15% lignin achieved the lowest charge-transfer resistance, with post-hoc tests confirming significant group differences, indicating that optimal performance depends on the specific electrochemical mechanism evaluated. Analytical findings indicate that ILLUMINA is an optically active, and economically available product that is adapted to the tropical environments, which allows Filipino communities to utilize equatorial position and the high UV index of the country by using sustainable, biomass-based photonic film that improves indoor lighting and energy consumption.

Awards Won: