Thin Film Coating of Poly(acrylic acid- vinylbenzyl chloride) as a Prime Layer for the Enhancement of Conductivity and Uniformity of PEDOT Synthesized by Vapor Phase Polymerization

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This study presents an effective strategy to enhance the conductivity, uniformity, and adhesion of poly(3,4-ethylenedioxythiophene) (PEDOT) thin films through interfacial surface engineering. A thin functional primer layer consisting of poly(acrylic acid-co-vinylbenzyl chloride) [P(AA-VBC)] was deposited via initiated chemical vapor deposition (iCVD) prior to PEDOT growth by vapor phase polymerization (VPP). The incorporation of this interfacial layer significantly improved the distribution of the oxidant on the substrate surface due to its hydrophilic nature, while the presence of chlorine-containing functional groups enabled in-situ doping during polymerization.

Comprehensive characterization using FTIR and XPS confirmed the successful formation of both the primer layer and the PEDOT films. Morphological analysis revealed a highly uniform and conformal coating on functionalized substrates compared to bare surfaces. Electrical measurements demonstrated a substantial enhancement in conductivity, reaching up to ~404 S/cm, which corresponds to nearly a fourfold increase compared to untreated substrates. Additionally, the films exhibited remarkable conductivity uniformity of up to ~96% across large areas. Mechanical stability tests further confirmed improved adhesion and durability of PEDOT films deposited on the functionalized surfaces.

The results highlight the critical role of interfacial engineering in vapor-phase polymerization processes and demonstrate a scalable approach for producing high-performance conductive polymer coatings. This method offers strong potential for applications in flexible electronics, wearable devices, sensors, and energy systems. Furthermore, the compatibility of iCVD and VPP techniques with various substrates makes this approach highly attractive for industrial-scale surface functionalization.

Keywords: Conductive polymer; PEDOT; iCVD; VPP; oCVD

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