

Figure S1. FTIR spectra of pristine, acid-treated, and silane-functionalized CNTs. Acid-treated CNTs exhibit a new band near $\sim 1720\text{ cm}^{-1}$ (C=O stretching of --COOH), while silane-functionalized CNTs show additional bands around $\sim 1100\text{ cm}^{-1}$ (Si–O–Si) and $\sim 1560\text{ cm}^{-1}$ (N–H bending), confirming the sequential introduction of oxygen-containing and silane groups.

Raw SEM/TEM Image Segmented CNT-Rich Domain

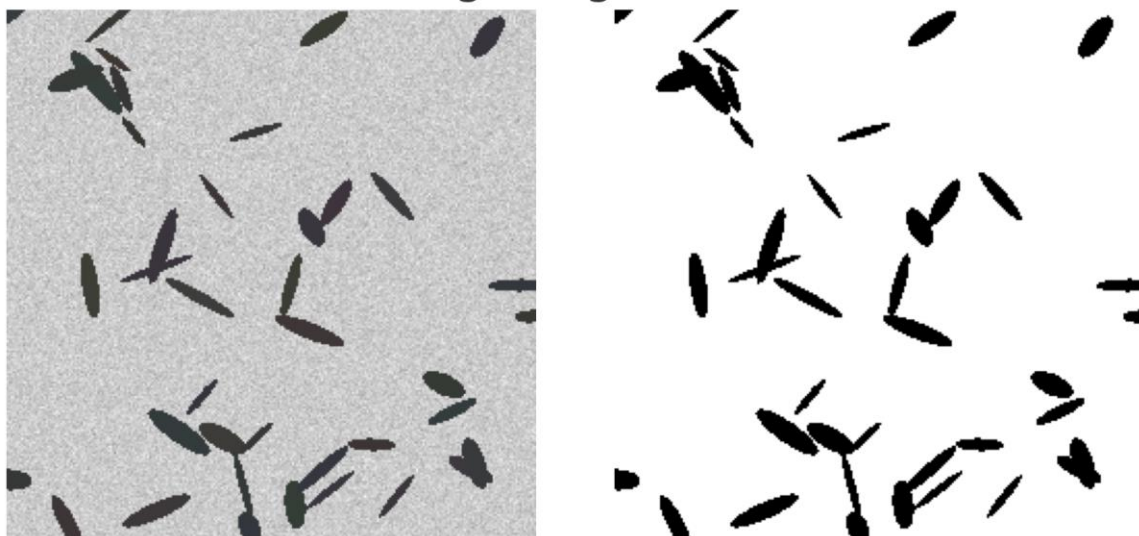


Figure S2. Representative raw (left) and AI-segmented (right) SEM/TEM images of CNT/PP composites. The segmented map highlights CNT-rich domains with reduced large agglomerates and a more homogeneous CNT distribution, consistent with the quantitative dispersion metrics used to correlate morphology with electrical and EMI performance.