Supporting information

Figure S1-FTIR spectroscopy of g-CNF

FTIR analysis was conducted on the g-CNF to determine the successful grafting of PLA. Figure S1 provides a visual representation of the vibrations observed in the spectra. The pure CNF exhibits stretching vibrations typical of glucose units at 3600-3000 cm^{-1}, corresponding to the broad spectral band of -OH groups. Additionally, C-H stretching is observed at 2930-2825 cm^{-1}, along with prominent peaks at 1150, 1077, and 990 cm^{-1}, corresponding to the stretching of C-O in C-O-H and C-O-C bonds. In the grafted CNF, many of the same peaks are present, but a new peak emerges at 1760 cm^{-1}, indicative of the carbonyl ester C=O bond present in PLA. Moreover, changes at 1250 cm^{-1} and 1055 cm^{-1} can be assigned to the vibration of ester groups C-O-R, also found in PLA.

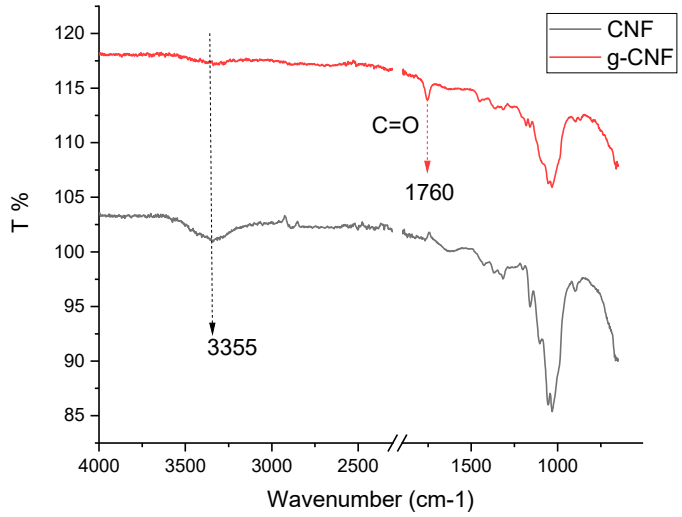

Figure S2-WAXS of g-CNF

The impact of grafting is evident in the XRD pattern of the altered CNF. A slight elevation in diffracted intensity at 2θ= 16.5 °C is observed in the grafted CNF, coinciding with the 2θ position of the principal peak of the L-lactide oligomer. Figure S2, illustrates the contrast among CNF, g-CNF, commercial PLA (IMF105), and L-lactide oligomer produced. The resemblance between the oligomer and commercial PLA bio-resin affirms the success of the polymerization reaction.

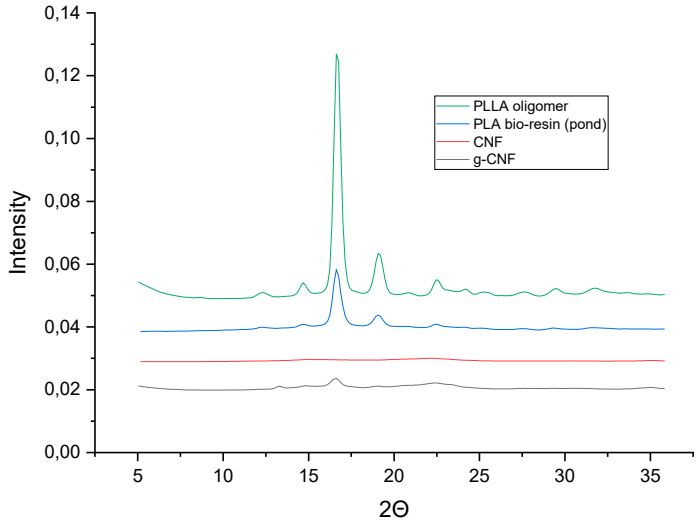

Figure S3-Film appearence of AM and binary blend of AM/PLA composites, and ternary blends with CNF and g-CNF composites.

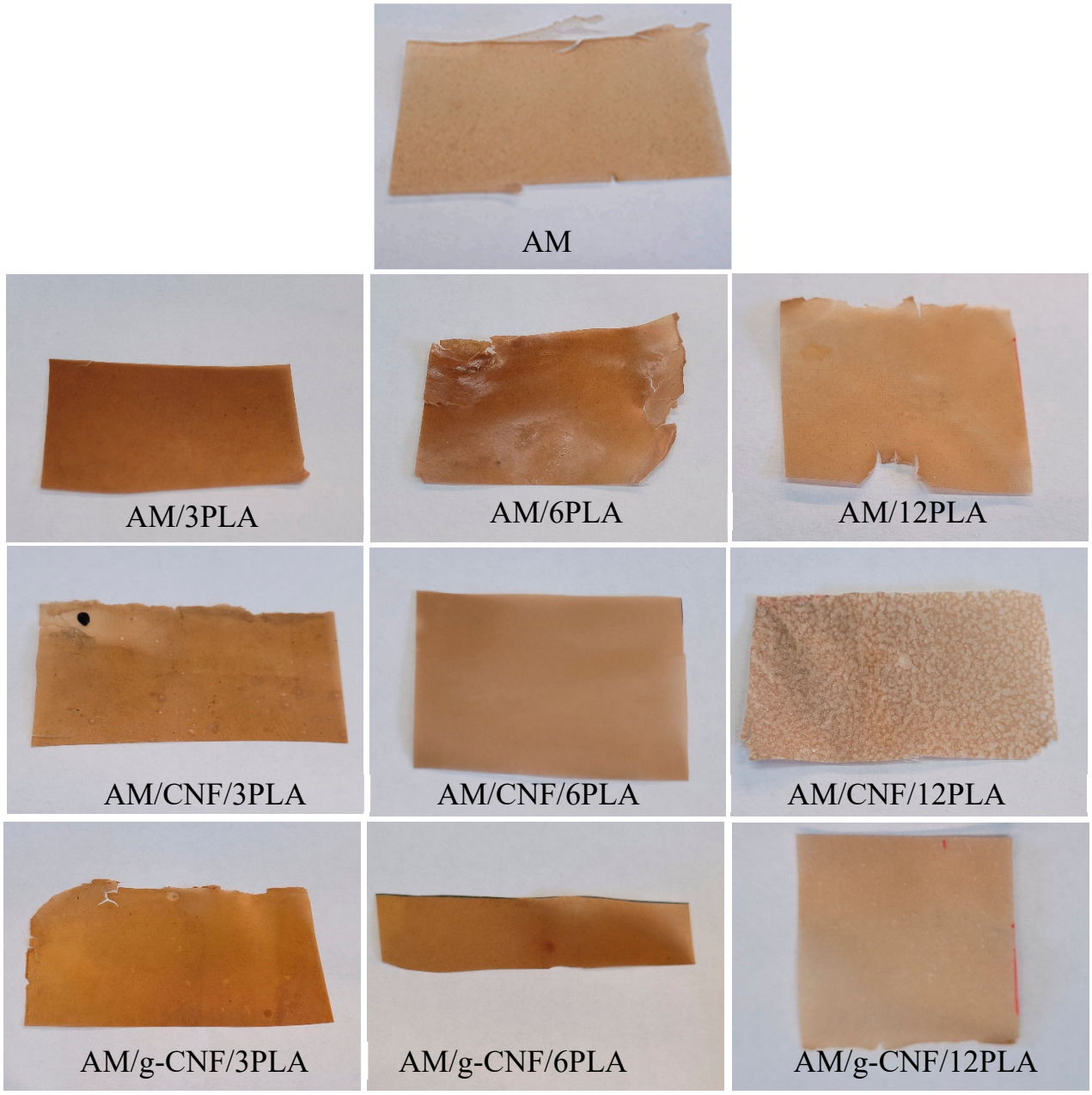

Figure S4- Morphology of binary blend of AM/PLA and Ternary blends of AM/CNF/PLA composites and AM/g-CNF/PLA composites. SEM image of the surface of a)pure AM film, (b-d) AM/PLA composite film, (e-g) AM/CNF/PLA , and (h-j) AM/g-CNF/PLA composite films.