LIST OF FIGURES

Figure 1.1: Different categories nanomaterials

Figure 2A.1: Structure of maleic anhydride

Figure 2A.2: FIIR spectra of PHE4h (resin and thermoset)

Figure 2A.3: ^{1}H NMR spectrum of PHE4h resin

Figure 2A.4: ^{13}C NMR spectrum of PHE4h resin

Figure 2A.5: Stress-strain profiles of PHE thermosets

Figure 2A.6: TGA thermograms of PHE thermosets

Figure 2A.7: Dielectric constants of PHE thermoset with the variation frequency

Figure 2B.1: Structure of TEA

Figure 2B.2: ^{1}H NMR spectrum of TAHE10

Figure 2B.3: ^{13}C NMR spectrum of TAHE10

Figure 2B.4: Curing of TAHE20 with combined hardener of PAA and PAD

Figure 2B.5: Stress-strain profiles of TAHE thermosets

Figure 2B.6: TGA thermograms of TAHE thermosets

Figure 2B.7: TGA thermograms of combine hardener cured TAHE20 thermosets

Figure 2B.8: Dielectric constants of TAHE20 thermosets cured with combined hardener system with the variation of frequency

Figure 2C.1: Structure of castor oil

Figure 2C.2: Structure of bis-MPA

Figure 2C.3: Structure of PTSA

Figure 2C.4: FTIR spectra of HBPP and HBPE2 resins

Figure 2C.5: (a) ^{1}H NMR and (b) ^{13}C NMR spectra of HBPP resin

Figure 2C.6: (a) ^{1}H NMR and (b) ^{13}C NMR spectra of HBPE2 resin

Figure 2C.7: Stress-strain profiles of HBPE and MSBE thermosets

Figure 2C.8: TGA thermograms of HBPE and MSBE thermosets

Figure 2C.9: (a) Variation of bacterial growth against exposure time for the thermosets and (b) weight loss of the thermosets after 60 days of exposure to the bacterial strain

Figure 2C.10: SEM images of bio-degraded thermosets: HBPE2 (a) control and (b) degraded, and SBE (c) control and (d) degraded

Figure 3A.1: XRD patterns of (a) pristine and modified bentonite, and (b) nanocomposites

Figure 3A.2: FTIR spectra of pristine bentonite, modified bentonite and MNC3

Figure 3A.3: (a) TGA thermograms of pristine and modified bentonite, and (b) pristine epoxy thermoset and nanocomposites

Figure 3A.4: (a) TEM and (b) SEM images of MNC3

Figure 3A.5: (a) Stress-strain profiles of the nanocomposites and (b) plots of tensile modulus of predicted and experimental values of nanocomposites

Figure 3B.1: Crude neem seed oil (NO) and its major compositions

Figure 3B.2: FTIR spectra of OMMT, NO, NO-OMMT and nanocomposite (PNC2.5)

Figure 3B.3: XRD patterns of OMMT, NO-OMMT and PNC2.5

Figure 3B.4: TEM images of PNC2.5, (a) 200 nm and (b) 50 nm magnification

Figure 3B.5: SEM images of the fracture surface of (a) pristine hyperbranched epoxy thermoset (TAHE20) and (b) nanocomposite (PNC2.5)

Figure 3B.6: Stress-strain profiles of the nanocomposites

Figure 3B.7: Antibacterial activity of the nanocomposites

Figure 3B.8: (a) Zones of inhibition of the nanocomposites against different bacteria and *C. albicans* fungus (b) antifungal activity of the nanocomposites (c) antifungal activity of PENC2.5 and (d) fungal growth curves of the nanocomposites

Figure 3B.9: Bacterial growth curves for the nanocomposites

Figure 3B.10: Number of *C. albicans* adherence on the surface of TAHE20 and PENC2.5

Figure 3B.11: TGA thermograms of pristine thermoset and the nanocomposites

Figure 4A.1: Picture of banana (*Musa acuminata*), used as the bio-source

Figure 4A.2: Structure of quinine sulfate

Figure 4A.3: TEM micrographs at different magnifications (a) 50 nm (b) 20 nm (with size distribution, inset) and (c) 5 nm, and (d) SAED pattern of carbon dot

Figure 4A.4: (a) EDX spectrum, (b) XRD pattern and (c) FTIR spectrum of carbon dot

Figure 4A.5: (a) ^{1}H NMR and (b) ^{13}C NMR spectra of carbon dot

Figure 4A.6: Spectra of carbon dot for (a) UV absorption, and PL with variation of (b) concentration, (c) pH and (d) excitation wavelength (340-420 nm)

Figure 4A.7: PL emission spectra of carbon dot at (a) 360 nm, (b) 400 nm, (c) 460 nm and (d) 520 nm excitation wavelengths

Figure 4A.8: PL spectra of quinine sulfate and carbon dot solution on excitation at 360 nm wavelength

Figure 4B.1: (a) FTIR spectra of hyperbranched epoxy, carbon dot and nanocomposite (ECD0.5); and (b) XRD patterns of carbon dot and nanocomposite (ECD0.5)

Figure 4B.2: TEM images of (a) ECD0.5, overview picture and individual integrated carbon dot with internal structure (insert in the picture) and (b) ECD1.0; and (c) SAED pattern of ECD0.5

Figure 4B.3: Stress-strain profiles of the nanocomposites

Figure 4B.4: (a) Photos for transparency and (b) visible light transmittance (%) of pristine epoxy and nanocomposite films

Figure 4B.5: Photos of hyperbranched epoxy thermoset and nanocomposites films at visible, short and long (from left to right) UV regions

Figure 4B.6: (a) UV and (b) PL spectra of the nanocomposites

Figure 4B.7. Luminescent photo of fingerprint under UV exposure at 365 nm

Figure 4C.1: FTIR spectra of carbon dot, PHE4h resin and CHE

Figure 4C.2: ^{1}H NMR spectra of (a) PHE4h resin, (b) CHE and (c) carbon dot

Figure 4C.3: ^{13}C NMR spectra of (a) PHE4h resin, (b) CHE and (c) carbon dot

Figure 4C.4: HR-TEM images of (a) CHE and (b) ECP at low magnification, and internal structure of (c) carbon dot, (d) ECP and (e) CHE at very high magnification

Figure 4C.5: SAED patterns of (a) carbon dot, (b) ECP and (c) CHE

Figure 4C.6: Stress-strain profiles of PHE4h, CHE and ECP thermosets

Figure 4C.7: TGA thermograms of CHE, ECP and PHE4h thermosets

Figure 4C.8: (a) Optical absorbance spectra; and (b) percent of transmittance and transparency (inset pictures) of PHE4h, ECP and CHE thermosets

Figure 4C.9: PL spectra of (a) CHE, ECP and carbon dot in ethanolic solution at same concentration (0.001%); (b) CHE (in ethanolic solution) with variation of concentration and (c) variation of excitation wavelength; and (d) CHE, ECP and PHE4h thermosets

Figure 4C.10: PL spectra of quinine sulfate and CHE solution on excitation at 360 nm wavelength

Figure 4C.11: Optical color emissions of (a) carbon dot, (b) CHE; and (c) CHE and ECP thermosets under exposure of UV lights at 254 and 365 nm

Figure 5A.1: FTIR spectra of carbon dot, carbon dot reduced Cu_2O nanohybrid and ECDCO1.0

Figure 5A.2: Optical absorption spectra of (a) carbon dot reduced Cu_2O nanohybrid and (b) ECD1.0 and ECDCO1.0

Figure 5A.3:TEM images: (a) high magnification (inset: the internal structure of Cu_2O), (b) low magnification (inset: the internal structure of carbon dot) of carbon dot reduced Cu_2O

nanohybrid, (c) TEM image of ECDCO1.0 and (d) selected area electron diffraction (SAED) pattern of carbon dot reduced Cu_2O nanohybrid

Figure 5A.4: XRD patterns for carbon dot reduced Cu_2O nanohybrid and ECDCO1.0

Figure 5A.5: Stress-strain profiles of the nanocomposites

Figure 5A.6: TGA thermograms for pristine thermoset and its nanocomposites with nanohybrid

Figure 5A.7: Plots of UV absorbance against wavelength at different times for degradation of paraoxon pesticide in the presence of (a) ECDCO1.0 and (b) ECD1.0 film, (c) plots of degradation rate for ECDCO1.0 (at dark and solar light), ECD1.0, nanohybrid; and (d) fitting curves for the ECDCO1.0 and ECD1.0 for pseudo-first order model

Figure 5B.1: TEM images of ECDCONC at (a) 100 nm and (b) 20 nm resolutions; and (c) SAED patterns of Cu_2O, carbon dot and their interlayer spacings obtained from TEM images

Figure 5B.2: XRD patterns of nanohybrids and MITH-NH2 nanocomposite

Figure 5B.3: TEM images of MITH-NH2 at different resolutions and positions: (a) at 0.2 μm, (b) 100 nm, (c) 100 nm at different position and (d) OMMT layer spacing at 20 nm resolution

Figure 5B.4: Stress-strain profiles of the nanocomposites

Figure 5B.5: TGA thermograms for pristine hyperbranched epoxy (TAHE20) and its nanocomposites with MITH-NH and carbon dot reduced Cu_2O nanohybrid

Figure 5B.6: Antimicrobial activity of hyperbranched epoxy nanocomposites with ECDCONC nanohybrid against (a) *Bacillus subtilis*, (b) *Klebsiella pneumonia*, (c) *Staphylococcus aureus* and (d) *Candida albicans*

Figure 5B.7: Bacterial growth curves of hyperbranched epoxy nanocomposites with MITH-NH nanohybrid against (a) *Staphylococcus aureus*, (b) *Bacillus subtilis*, (c) *Klebsiella pneumoniae* and (d) *Pseudomonas aeruginosa* bacteria

Figure 5B.8: Antibacterial activity of MITH-NH1, MITH-NH2 and MITH-NH3 against (a) *Staphylococcus aureus*, (b) *Bacillus subtilis*, (c) *Klebsiella pneumoniae* and (d) *Pseudomonas aeruginosa* bacteria

Figure 5B.9: Antifungal activity of MITH-NH1, MITH-NH2 and MITH-NH3 against *Candida albicans*, (a) zone of inhibition and (b) growth curves

Figure 5B.10: Release profile of MITH biocide for MITH-NH3

Figure 5B.11: Number of *Candida albicans* adherence on the surface of TAHE20 and MITH-NH2

Figure 5B.12: (a) Transparency and (b) optical color emission of the nanocomposites