

Vegetable Oil Based Polyurethanamide/Organo-Montmorillonite Bio-Nanocomposite

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ABSTRACT: The present work describes the synthesis and characterization of polyurethanamide/organo-montmorillonite bio-nanocomposites (OBNC) from Linseed oil—a renewable resource. The aim of the work is (i) to widen the scope of application and improve the performance of vegetable oil based polymers, and (ii) to investigate the effect of introduction of modified clay on their structure, morphology, thermal stability, and coating properties. OBNC has been prepared by *in situ* polymerization of Linseed oil derived diol fattyamide and toluylene-2,4-diisocyanate in the presence of different contents of OMMT (0.5–2.5 mass % in minimum amount of dimethylformamide) at room temperature. OBNC has been characterized by optical microscopy, FTIR, XRD, TEM, and TGA, which confirm the formation of OBNC. OBNC produced tough, scratch-resistant, impact resistant, flexibility retentive coatings, which cure at room temperature with improved coating performance and thermal stability than virgin polymer. Amongst all the compositions, OMMT-1.5 showed the best coating properties, with good scratch hardness (3.5 kg), impact (passes 200 lb/inch.) and bent test values (passes 1/8 inch). It can be commercially used as effective green coating material in future. © 2014 Wiley Periodicals, Inc. *J. Appl. Polym. Sci.* **2014**, *131*, 40278.

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INTRODUCTION

In recent times, the best way for upgradation of the pristine polymers is via the formation of their nanocomposites, which broadens their area of applications. The relatively low loading of nano-meter-sized inorganic particles in polymers shows dramatically enhanced physico-mechanical, thermal, electrical and other properties such as stiffness, heat distortion temperature, dimensional stability, gas barrier property, electrical conductivity, and flame retardancy in comparison to pristine polymers or conventional composites.¹ Bio-nanocomposites (BNCs) have become a promising new field of research. BNCs are made of natural polymer matrix or renewable resources derived polymer matrix and organic/inorganic fillers with at least one dimension on the nanometer scale.² Natural polymer resources such as chitosan,³ starch,⁴ cellulose,⁵ polylactic acid,⁶ vegetable oil derivatives^{7,8} have been used in the development of BNCs. Among various sustainable resources, vegetable oils have been identified as natural biomaterials with excellent bioactivity, biodegradability, biocompatibility, nontoxicity with multi functional groups.⁹

They find applications in the development of low molecular weight polymers such as alkyds, polyesters, polyesteramides, polyepoxies, polyols, polyurethanes (PU) for adhesives, printing inks, anticorrosive, antibacterial, antifungal applications, and others.¹⁰ These polymers can be reinforced with different fillers, which enhance the performance of the virgin polymer. Conventional nanofillers like talc, mica, CaCO₃, kaolin, clays, fumed silica, carbon nanotubes, and glass fibers have been found to improve the performance of the virgin polymers.^{11,12}

Nanoscale clays, organo-montmorillonite (OMMT) are choices of major polymer nanocomposite researches.¹³ Here, very small percentage of such fillers are accountable for the enhancement of properties as mentioned above due to high surface area, high aspect ratio (ratio of length to thickness, 50–1000), stiffness, platelet thickness (10 Å) and inplane strength of polymers.¹⁴ When these organoclay are mixed with polymers, three types of nanocomposites are generally formed: (i) tactoid formation, (ii) intercalation, or (iii) exfoliation. Former type is microscale composite and clay only serves as conventional filler. In this

case, complete clay particles are dispersed within the polymer matrix and the layers do not separate. The latter two types are ideal nanoscale composites. Intercalation occurs when a small amount of polymer is inserted between the layers of the clay, thus expanding the interlayer spacing and forming a well-ordered multilayer structure. In exfoliation, the layers of the clay are separated completely and the individual layers are distributed throughout the polymer matrix. The formation of intercalation or exfoliation depends on the type of organoclay and also on processing conditions.¹⁵ A number of researchers have presented their work in the field of renewable resource based nanocomposite materials such as poly(L-lactic acid)/nanoclay,⁶ starch/nanoclay,⁴ protein/nanoclay¹⁶ and modified oil based polymers/nanoclay.^{2–17} Among them oil based monomers or polymers/nanoclay nanocomposites get more attention and the approach may greatly overcome the dependence upon petro-based materials.^{18–23}

PU is an extraordinarily versatile material which shows two-phase morphology arising from the nonhomogeneity of the hard (diisocyanate) and soft (dihydroxy/polyhydroxy) segments. The properties of PU can be tailored according to the uses by the variation of composition and structure of soft and hard segments or by physical modification like blending or through interpenetrating network formation with other polymers.²⁴ Therefore, PU are being utilized in diverse fields of applications such as foams, elastomers, fibers, biomedicines, coatings, and paints.^{24–27} However, some advanced applications demand high mechanical strength, chemical resistance, thermostability, low water vapors permeability, and others, which can be obtained through modifications by nanofillers such as nanoclays. Aruna Palanisamy has synthesized water-blown PU–clay nanocomposite foams from biopolyol and discussed the effect of nanoclay on their properties.²⁸ Pradhan and Nayak have synthesized and characterized PU nanocomposite derived from castor oil-hexamethylene diisocyanate.²⁹ Gaidukov et al. have reported the preparation and characterization of intercalated and exfoliated nanocomposites free standing films of bio-based rigid PU from rapeseed oil and diethanolamine (DEA) polyol and modification with OMMT nanoparticles. The study reveals enhanced thermal degradation characteristics of the prepared PU /OMMT nanocomposites upon heating in air atmosphere.³⁰ Gautam Das et al. have reported Mesua ferrea L. seed oil based hyperbranched polyurethane (HBPU) treated epoxy system and nanocomposites with best composition (30 wt % HBPU) with different dose levels of organo nanoclay (1, 3, and 5 wt %). The composites were characterized by using wide angle X-ray diffraction (WAXD), SEM, TEM, and FTIR techniques. The nanocomposite with 5 wt % of clay shows an increase of about 230% in tensile strength with respect to the pristine epoxy system and exhibited significant degradation, to be used as an advanced biodegradable coating material.³¹ Literature survey reveals that generally PU/clay nanocomposites have been prepared by cumbersome multistep process, high temperatures and times.

The present manuscript discusses the synthesis and characterization of vegetable seed oil derived bio-nanocomposite, polyurethanamide (PULFA)/OMMT (OBNC) by simple method and then to investigate the effect of OMMT on structure, physico-mechanical, chemical/corrosion resistance performance and thermal stability of the bio-nanocomposite. These performances

were compared with the virgin polymer, PULFA coatings.³² Our investigations reveal that with the loading of OMMT in PULFA improves the physico-mechanical and chemical/corrosion resistance performances along with thermal stability of OBNC.

EXPERIMENTAL

Materials

Vegetable seed oil (Linseed oil, procured from local market, Delhi), toluylene-2,4-diisocyanate (TDI; Merck, Germany), *N,N*-dimethylformamide (DMF, Merck, India) and organo-montmorillonite (OMMT) (Cloisite 30B; modified by an alkyl ammonium cation bearing two primary hydroxyl functions, alkyl group is tallow containing ≈65% C18, ≈30% C16, and ≈5% C14, Southern Clay product) were used without further purification.

Synthesis of Linseed Oil Based Diol Fattyamide and PULFA

Linseed oil based diol fattyamide (LDFA) and PULFA were prepared by reported methods.³² LDFA was synthesized by the reaction of linseed oil (60 g, 0.2 mol) and DEA (50 mg, 0.64 mol) in presence of sodium methoxide (0.26 g, 0.014 mol) at 120°C. Thin layer chromatography (TLC) was used to monitor the progress of the reaction. After the completion of the reaction the reaction mixture was cooled, dissolved in dimethyl ether, washed with 15% aqueous NaCl solution and then dried over anhydrous sodium sulphate. The solvent was removed by a rotatory vacuum evaporator and pure LDFA was obtained. Their PULFA was prepared by using a one-shot technique with LDFA (1.0 moles) and TDI (1.0 moles, solution in minimum possible DMF solvent) at room temperature. The progress of the reaction was monitored by TLC and hydroxyl value (HV) at regular interval. After completion of reaction solvent was removed through rotary vacuum evaporator to obtain pure PULFA.

Synthesis of OBNC

The preparation of OBNC was carried out *in situ* by the addition of OMMT (0.5–2.5 mass % in DMF) during the preparation of PULFA³² at room temperature under continuous stirring. OMMT was added in small portions in the flask which contains reaction mixture (LDFA and TDI) of PULFA, slowly over a period of 15 min under continuous stirring. The progress of the reaction was monitored by TLC and HV. At desired HV the reaction was stopped and solvent of the reaction mixture was separated by rotary vacuum evaporator. The final products were termed as OBNC-0.5, OBNC-1.5, and OBNC-2.5, where suffix indicate the mass % of MMT.

CHARACTERIZATIONS

HV and TLC method were used to monitor the progress of the reactions. They were carried out by standard laboratory methods.³³ Refractive index was also recorded by standard laboratory method. FTIR measurements were conducted on IRPrestige-21, IRAffinity-1, FTIR-8400S (Shimadzu Corporation Analytical and Measuring Instrument Division, F.R. Germany) using a NaCl cell at room temperature (28–30°C). An optical microscope (Leitz, Wetzlar, Germany) was used to study the morphology of OBNC materials and their coatings. X-ray diffraction (XRD) study was carried out by using X-ray diffractometer

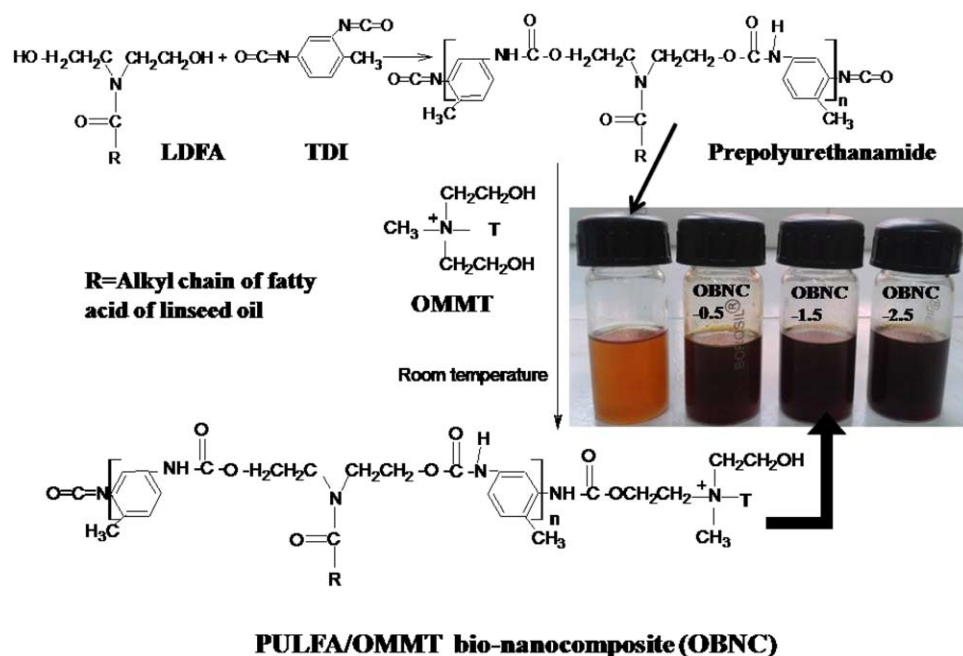


Figure 1. Synthesis of OBNC. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

(Philips model PW3710) using Cu K α radiation ($\lambda = 0.15406$ nm) and the diffractogram was scanned in the ranges from 5 to 30° at a scan rate of 1° min⁻¹. Transmission electron microscopy (TEM) of OBNC was observed on a carbon coated copper grid by the use of Morgagni 268-D TEM FEI instrument, Netherlands. Thermogravimetric analysis (TGA) was carried out by Perkin-Elmer Diamond analyzer (Shelton, CT) from 30 to 700°C in nitrogen atmosphere at 10°C/min heating rate. The coatings of OBNC-0.5, OBNC-1.5, and OBNC-2.5 were prepared by brush technique using 70 wt % of resin in DMF on commercially available mild steel strips (MS) size 70 × 25 × 1 mm³ for physico-mechanical and 30 × 10 × 1 mm³ for chemical/corrosion resistance tests to evaluate the coating performance. MS were first polished with silicon carbide papers of different grades (180, 320, and 500), followed by thorough rinsing with water, alcohol and acetone which was further followed by drying with hot air blower in air, and then coated with OBNC-0.5, OBNC-1.5, and OBNC-2.5 solution. These coatings were dried at room temperature and the performance of the same compared with PULFA coatings. Physico-mechanical tests such as scratch hardness (SH) (BS 3900), impact resistance (IRt) (IS; 101 part 5/sec-3, 1998) and bending ability (BT) (ASTM-D 3281-84) of the coatings were performed. The chemical/corrosion resistance tests of OBNC-0.5, OBNC-1.5, and OBNC-2.5 were performed in different chemical or corrosive environments such as xylene, water, 5 wt % HCl and 2 wt % NaOH, by pouring their solutions in porcelain dishes and dipping the coated samples in the aforementioned media. The periodic examination of these coatings was conducted until the evidence of softening or deterioration of the same was observed (Table III). A salt-spray test (ASTM B177-94) of OBNC-0.5, OBNC-1.5, and OBNC-2.5 was also carried out in 3.5% NaCl for a period of 15 days in a salt mist chamber. The specular

gloss of OBNC-0.5, OBNC-1.5, and OBNC-2.5 was determined at 45° by a gloss meter (model RSPT 20; Digital Instrument, Santa Barbara, CA). Coating thickness of OBNC-0.5, OBNC-1.5, and OBNC-2.5 was measured by Elcometer Model 345 (Elcometer Instruments, Manchester, UK) and was found within the range of 106–107 μ m.

RESULTS AND DISCUSSION

OBNC was synthesized *in situ* via addition polymerization reaction between free NCO groups of PULFA and OH of OMMT surface (Figure 1).³⁴ Generally, four methods have been used to synthesize nanocomposites: solution intercalations, *in situ* polymerization, melt intercalation, and template synthesis.³⁵ We have used *in situ* polymerization for the synthesis of OBNC in the present work since it utilizes clay both as a filler material for the composite and as a support and activator for the polymerization catalyst.³⁶

Different kinds of cation exchanged montmorillonite (Cloisite) have been studied, among them OMMT (Cloisite 30B) is chosen for the present work because it has previously shown promising results.³⁵ For Cloisite 30B, strong hydrogen bonding between hydroxyls on the Cloisite 30B molecules along with hydroxyethyl, amides and urethanes groups on PULFA molecules favored the formation of bio-nanocomposite. The

Table I. HV and Refractive Index of All Compositions of OBNC

Resin code	PULFA ³²	OBNC-0.5	OBNC-1.5	OBNC-2.5
HV (%)	4.04	3.12	3.02	2.89
Refractive index	1.508	1.515	1.517	1.519

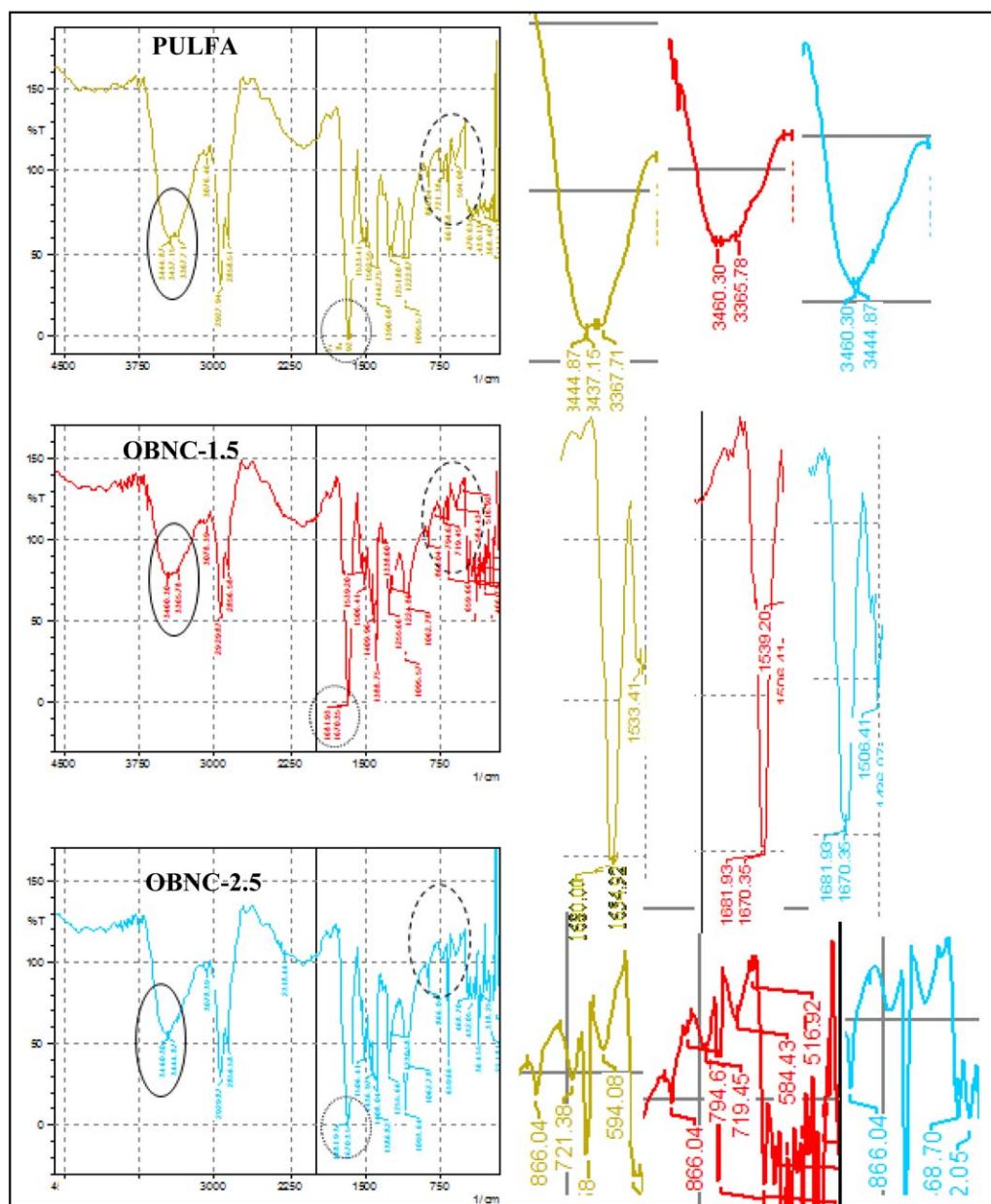


Figure 2. FTIR of virgin polymer and OBNC. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

refractive index of OBNC slightly increases while HV of OBNC slightly decreases with the loading of OMMT due to chemical reaction between free $-NCO$ of PULFA and hydroxyl groups of OMMT, which get consumed during the reaction as shown in Figure 1 (Table I). The occurrence of secondary reactions of PU also cannot be ruled out (such as chemical reaction between urethane linkages and hydroxyl groups of OMMT).²⁷ These results along with the results of FTIR spectrum confirmed the reaction of free NCO of PULFA and OH groups of OMMT in the formation of OBNC.

Spectral Analysis

FTIR spectra [Figure 2(a)] shows the characteristic peaks of virgin polymer [some peaks such as at (cm^{-1}) 3367.71 (residual –

OH), 3437–3445 (stretching, N–H of urethane), 3076.46 (stretching, Ar C=C–H), 1678 and 1662.64 (stretching, $>C=O$ urethane and amide), 2927.94 (stretching, $-CH_2$ asym), 2858.51 (stretching, $-CH_2$ sym), 1222.87 (stretching, NCOO–), 661.58 (bending, N–H urethane)].³² Figure 2(b,c) spectra of OBNC-1.5 and OBNC-2.5, respectively, show the characteristic peaks of virgin polymer [Figure 2(a)] along with some additional peaks.^{31,37} These additional peaks observed at 516.92 cm^{-1} (Al–O stretching vibration, low intensity), 794.6 cm^{-1} (Si–O–Si sym stretching, low intensity) and 3460.30 cm^{-1} ($-OH$ of clay that located on the surface of the clay).^{31,37} The shifting of $>C=O$, $-OH$ and $-NH$ peaks along with broadening of later two peaks are collectively correlated to the presence and utilization of OMMT in formation of OBNC.³⁸ FTIR spectra cannot

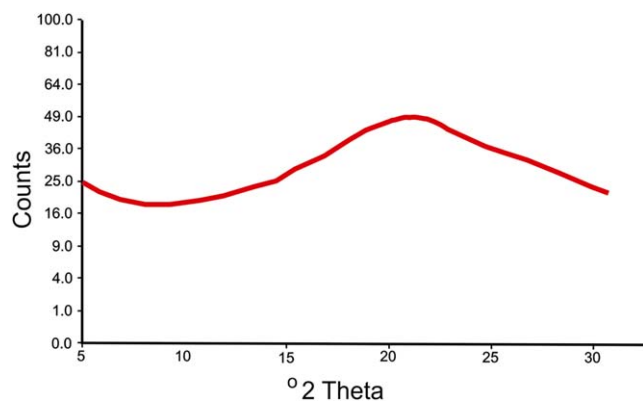


Figure 3. X-ray diffraction patterns of OBNC-1.5. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

confirm the formation of intercalated or exfoliated composite but presence of additional peaks, shifting and suppression of characteristic peaks can correlate to the existence of OMMT in the composite.

Morphology of OBNC

XRD. By the comparison of X-ray diffraction patterns of OBNC-1.5 (Figure 3) with OMMT,³⁹ it reveals that no sharp peaks observed in case of OBNC-1.5 that was presented in OMMT (corresponds to the (001) basal reflection of the organoclay).^{38,39} This result indicates that the *d*-spacings between layers are so large that the fillers formed exfoliated structures.^{37,39} This exfoliation may have been brought about by the side chains of the polymer matrix dispersing into the spaces among layers to exfoliate the layers, which are facilitated by the reaction between the tallow modifier chains of OMMT and the PULFA matrix.⁴⁰ The appearance of broad peak in XRD also

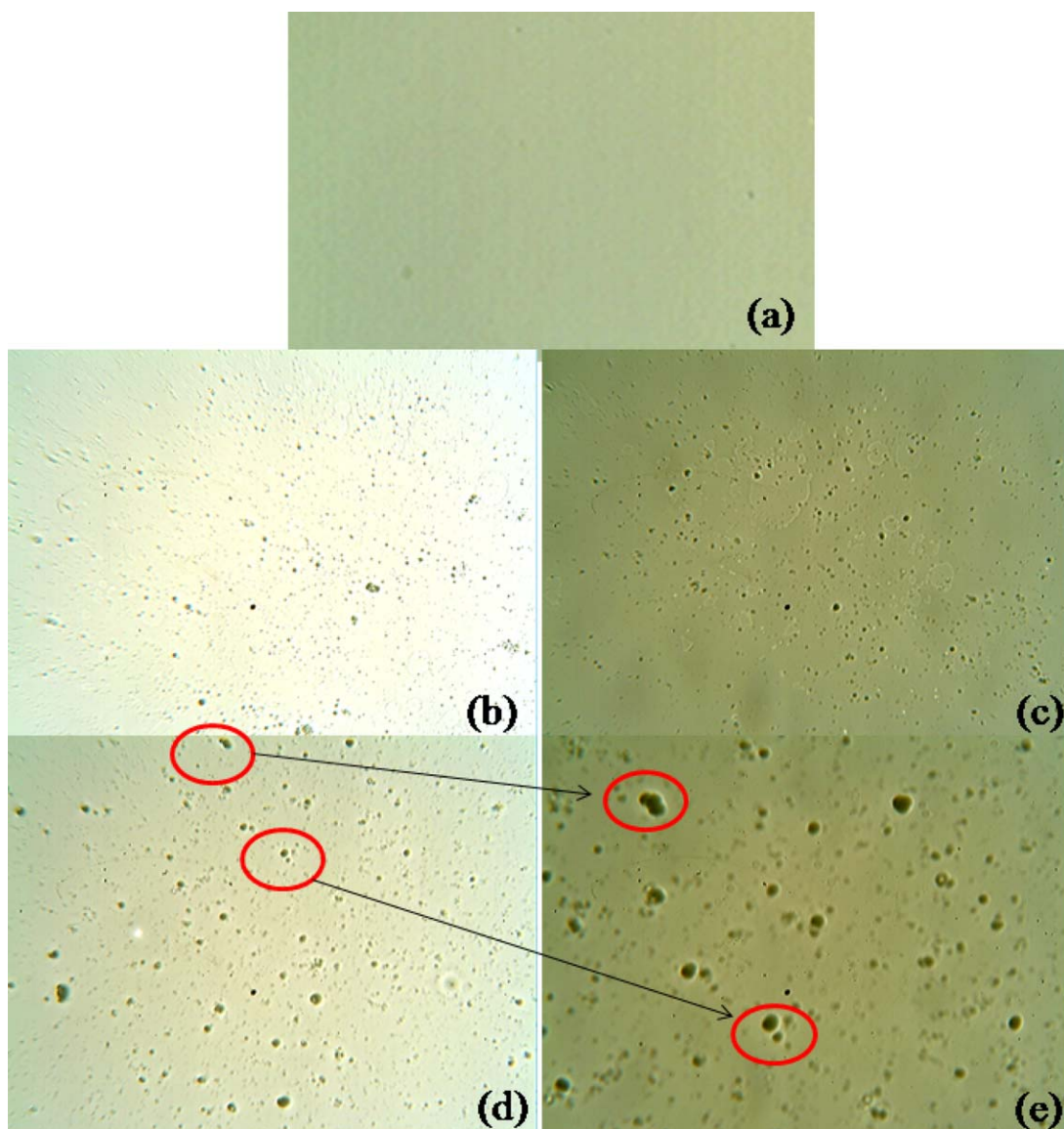


Figure 4. Optical micrographs of PULFA at 100X (a), OBNC-1.5 at 100X (b) and 200X (c), OBNC-2.5 at 100X (d) and at 200X (e). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

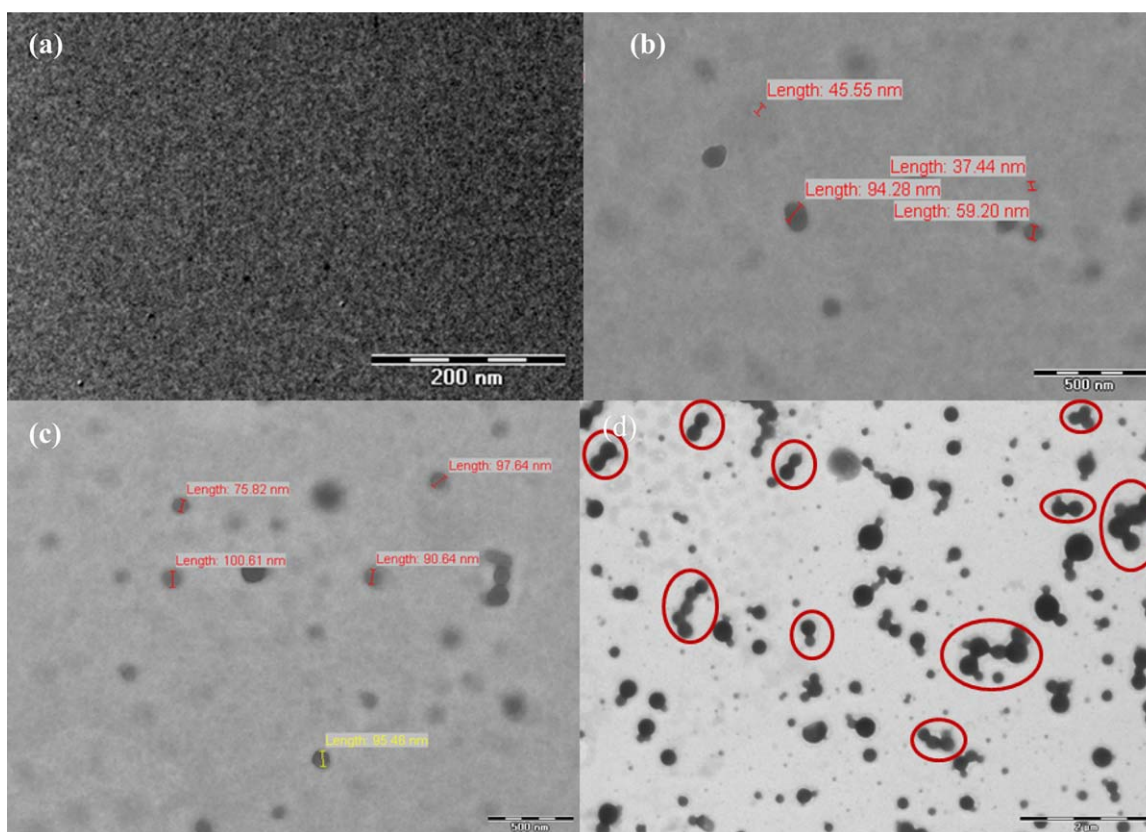


Figure 5. TEM micrograph of (a) PULFA, (b) OBNC-0.5, (c) OBNC-1.5, and (d) OBNC-2.5. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

supports the amorphous nature of OBNC as also observed in an earlier publication.⁴¹

Although it is a common practice to classify the nanocomposite as fully exfoliated from the absence of (001) reflection, however, it is difficult to reach a definitive conclusion about the defined structure from the XRD alone. Thus, TEM techniques are necessary to characterize the composites.

Optical Micrographs. The microstructure of OBNC as observed by optical micrographs (Figure 4), which show the presence of clay particles as globules in OBNC-1.5 matrix [Figure 4(b,c)], while these are absent in PULFA [Figure 4(a)]. These globules further adhere with each other as observed in the optical micrographs of OBNC-2.5 [Figure 4(d,e) at 100X and 200X, respectively], which is also observed in TEM micrographs as discussed below.

TEM Micrographs. The micrographs of OBNC (Figure 5) clearly show the presence of OMMT as spherical particles embedded in the PULFA matrix due to chemical reaction between $-NCO$ of the polymer and $-OH$ of OMMT (also supported by FTIR). The comparison of TEM micrographs of virgin polymer and OBNC show loose assemblage of globular clay particles of size ranging from 37 to 94 nm in OBNC 0.5. At higher loading, in OBNC-1.5 the presence of clay as 75–100 nm globules is evident, indicating no visible effect on the morphology of nanocomposites⁴², relative to OBNC-0.5 with visible increase in dimension of clay globules only. However, at 2.5

mass % loading, in OBNC-2.5, adherence of two to five clay globules becomes preponderant. The morphology of OBNC shows two, three, or four globular particles well adhered together or more than four globular particles existing as “beaded together.”

Coatings Properties of OBNC

Microstructure of OBNC Coatings. Microstructure of OBNC coatings was investigated by optical microscopy (Figure 6). The optical micrographs of OBNC-1.5 and OBNC-2.5 [Figure 6 (b–e)] show the presence of clay globules embedded in the PULFA matrix, while these are absent in zero clay PULFA, where PULFA chains appear as entanglements free of any particles [Figure 6(a)]. The clay particles are clearly visible as encapsulated by the PULFA chains in OBNC-1.5 (at 100X and 200X) [Figure 6(b,c)]. The microstructure shows uniform and homogenous distribution of clay particles embedded in the chain entanglements of PULFA that also improves the coating performance as discussed in preceding sections. However, at OBNC-2.5 [Figure 6(d,e)] these entanglements become more pronounced with higher content of clay particles, and this leads to deterioration of coating performance as described below.

The coatings of OBNC (Figure 7) were Zobtained at ambient temperature (28–30°C) for 60–120 min without any crosslinker as PULFA coatings³² (Table II). The table reveals that drying time of OBNC coatings was higher than that of PULFA

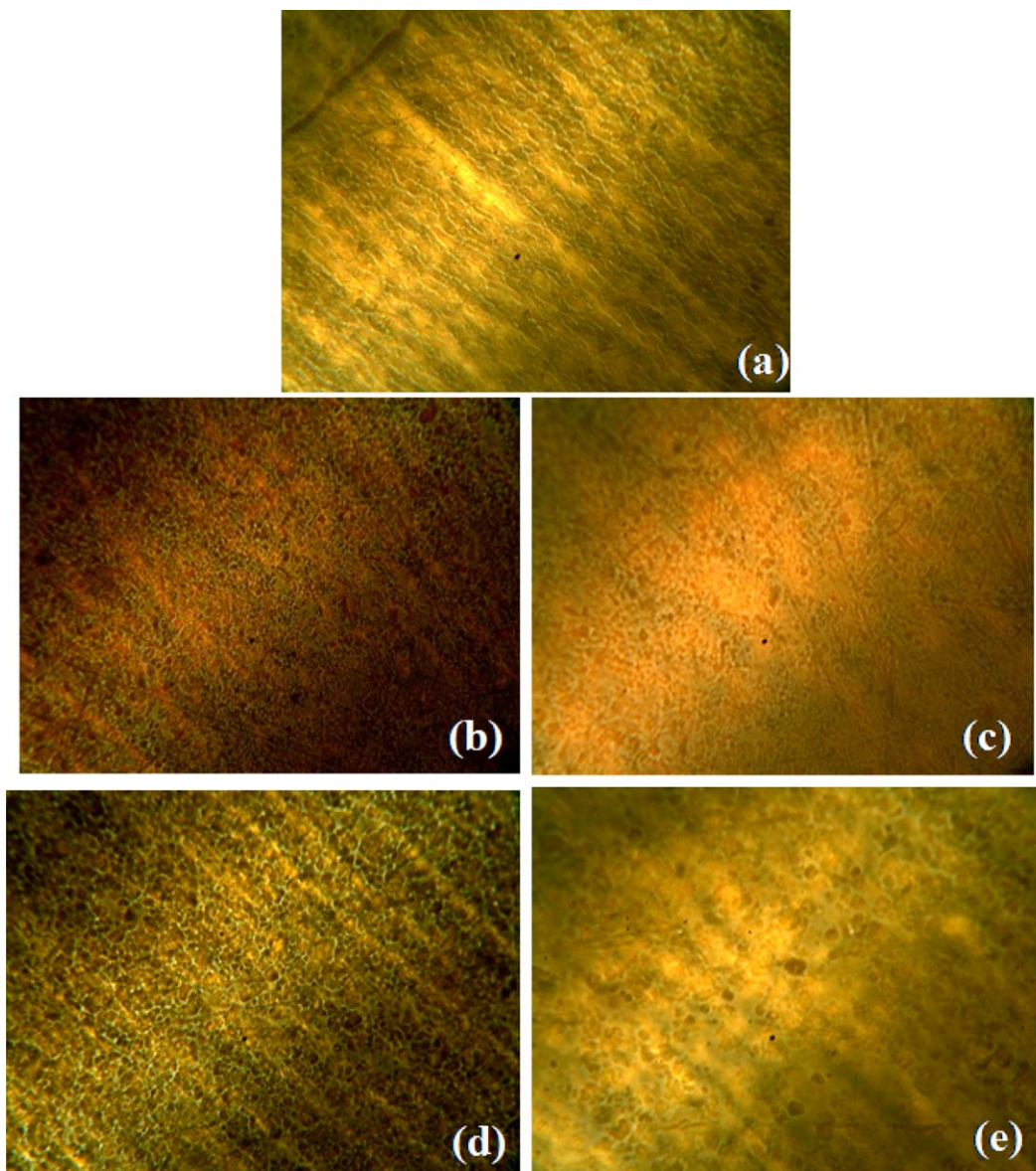


Figure 6. Optical micrographs of PULFA coatings at 100X (a), OBNC-1.5 coatings at 100X (b) and 200X (c), OBNC-2.5 coatings at 100X (d) and at 200X (e). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

coatings. It further increases with loading of OMMT. The curing mechanism of OBNC is same as observed in virgin polymer that is solvent evaporation, followed by the chemical reaction of free -NCO groups of OBNC with atmospheric moisture and auto-oxidation at alkyl fatty chain, at ambient temperature. The higher drying time for the curing of OBNC can be correlated to the decreased number of free -NCO groups available for curing, as they get consumed when in contact with increased content of OMMT (as also discussed in an earlier section). Physico-mechanical tests of OBNC-0.5 to OBNC 2.5 coatings were also tabulated in Table II. It reveals that scratch hardness (kg) of all compositions of OBNC coatings was higher than that of PULFA. Scratch hardness further increases with the increase in the loading of OMMT up to OBNC-1.5 thereafter, decreases at OBNC-2.5. All coatings except OBNC-2.5 were passed impact (200 lb/inch) and bending (1/8 inch) tests. The gloss value

(degree) of OBNC was higher than that of PULFA. It further slightly increases with loading of OMMT upto OBNC-1.5 after that decreases at OBNC-2.5. The higher values of aforementioned tests may be correlated to long fatty acids chains (which enhance the flexibility of coatings)⁴³ and the presence of polar groups of the polymer and OMMT that provide good cross-linking, flexibility as well as adhesion of the coatings to the substrate for the formation of well adhered infusible thermoset coating system.⁴⁴ In vegetable oil based coatings, generally good flexibility characteristic is observed correlated to the tendency of long fatty alkyl chains that impart flexibility to the coatings.⁴³ Whereas aforementioned test failed to show satisfactory properties at OBNC-2.5 can be correlated to the higher cross-linking (due to electrostatic interactions between polar groups that present in the polymer chain and OMMT) that causing

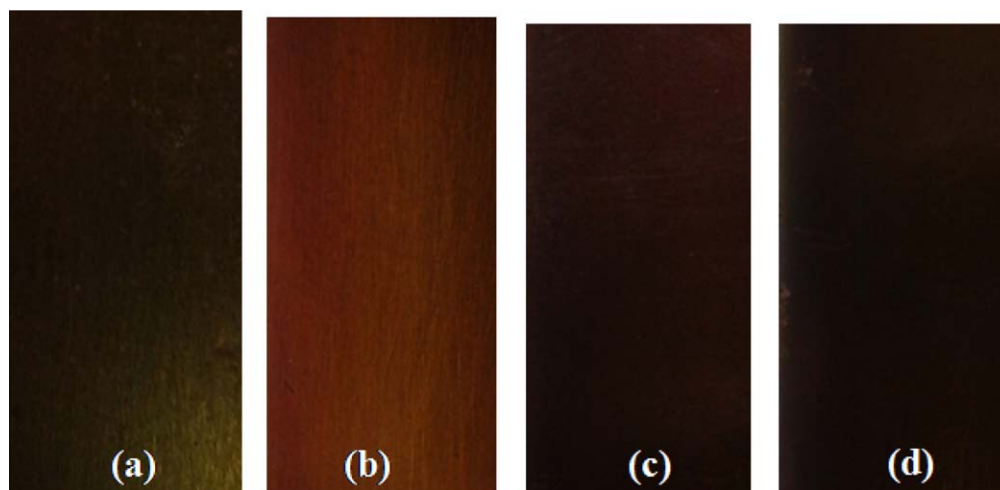


Figure 7. Coatings photograph of PULFA (a), OBNC-0.5 (b), OBNC-1.5 (c), and OBNC-2.5 (d). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

Table II. Physico-Mechanical Tests of All Compositions of OBNC Coatings

Resin code	PULFA ³²	OBNC-0.5	OBNC-1.5	OBNC-2.5
Drying time (min)	20	60	70	120
Gloss (45°)	73	82	82	83
Thickness (μm)	106	106	107	108
Scratch hardness (kg)	2.5	3.0	3.5	2.8
Impact resistance (200 lb/in.)	Pass	Pass	Pass	Fail
Bending (1/8 in.)	Pass	Pass	Pass	Fail

brittleness within the coating material as also supported by the microstructure of OBNC-2.5 coating described above.

Table III shows values for the chemical/corrosion resistance and salt spray tests results of all compositions of OBNC coatings and their comparison with those of PULFA coatings.³² It reveals that coatings of OBNC show improved results in all corrosive environments with the loading of OMMT than those of PULFA coatings. The coatings of OBNC-1.5 composition show best results amongst the all the OBNC systems. These results can be correlated to the barrier nature of dispersed OMMT in PULFA matrix that improves the coating performance.

It was observed that coatings of OBNC-1.5 were obtained as hard and glossy coatings with good scratch hardness, impact resistance, flexibility, and also performed well in different chemical/corrosive media compared to PULFA coatings. OBNC-1.5 coating system comprises an optimum combination of amide, ether, urethane, Si-O-Si groups along with pendant alkyl chains. It shows an optimum cross-linked structure with polar groups, which facilitate good adhesion to the substrate. The completely cured OBNC coatings serve the function of corrosion protection, primarily by acting as an efficient barrier that prevents the diffusion of chief corrodent, e.g., oxygen and water along with the corrosive ions of various media.⁴⁵ As a result, the coatings

Table III. Chemical/Corrosion Resistance Performance of All Compositions of OBNC Coatings

Resin code	PULFA ³²	OBNC-0.5	OBNC-1.5	OBNC-2.5
2 % NaOH	Slight loss in gloss (3 h)	Unaffected (6 days)	Unaffected (6 days)	Slight loss in gloss (6 days)
3% HCL	Unaffected (10 days)	Slight loss in gloss (10 days)	Slight loss in gloss (10 days)	Slight loss in gloss (10 days)
Xylene	Unaffected (10 days)	Unaffected (10 days)	Unaffected (10 days)	Unaffected (10 days)
Water	Unaffected (10 days)	Unaffected (15 days)	Unaffected (15 days)	Slight loss in gloss (15 days)
3.5% NaCl	Slight loss in gloss (10 days)	Slight loss in gloss (12 days)	Slight loss in gloss (12 days)	Loss in gloss (12 days)

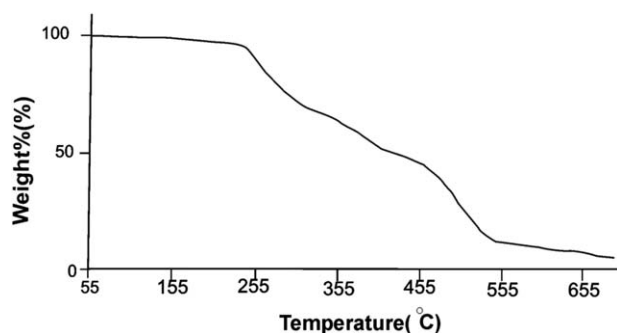


Figure 8. TGA thermogram of OBNC-1.5.

show good resistance against attack of chemical/corrosive agents.

Thermal Analysis

Thermal stability of OBNC-1.5 is observed by TGA. The thermogram of OBNC-1.5 (Figure 8) show more than one decomposition steps which are same as observed in the case of virgin PULFA.³² Initially, around 1–2 wt % losses are observed at 180–200°C related to entrapped moisture. A 5 wt % loss was observed at 250–260°C. The residue (wt %) observed in TGA thermogram of OBNC-1.5 at 650°C was absent in the virgin resin.³² Thermal stability of OBNC-1.5 is found better than that of PULFA. It was also observed from the TGA thermogram of OBNC-1.5 that the temperature of thermal degradation slightly increased with the increased loading of clay content. The higher thermal stability and weight residue of OBNC-1.5 are due to heat barrier nature of OMMT leading to the restricted motion of polymer chains and the longer path of diffusion for volatiles offered by MMT layers that increase the thermal stability of the system and weight residue formation during thermal decomposition.^{2,46}

CONCLUSION

The bio-nanocomposite (polyurethanamide/organo-montmorillonite) was successfully synthesized by simple and shortest route from linseed oil derived polyurethanamide and OMMT (0.5–2.5 mass % of the polymer) at room temperature. XRD and TEM analyses showed that OMMT was well dispersed in the polymer matrix. Thermal stability of the bio-nanocomposite increased with OMMT content. It was observed that OBNC-1.5 coating was obtained as hard and glossy coatings with good scratch hardness, impact resistance, flexibility, which also performed well in acid, alkali, xylene, and water media compared to PULFA coatings. Our investigations revealed that the prepared bio-nanocomposite may find commercial utility as environment friendly and cost effective coatings material.

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