# Effect of Novel Magnetic Nanoparticles on Morphology properties of Polyurethane Foam

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## Abstract

Polyurethane rigid foam (PUR) nanocomposite contain of novel magnetic (MNPs) core-shell nanoparticles ($Fe_3O_4$/Silica/Urea-1 and 3wt%) was prepared by in situ polymerization method. The structure of nanoparticles was investigated by Fourier transform infrared spectroscopy (FT-IR) and scanning electron microscopy (SEM). The effect of the MNPs nanoparticles on morphology properties of PUR was studied.

**Keywords**: Polyurethane foam, morphology, magnetic nanoparticles

### 1. Introduction

Polyurethanes (PUs) used in various applications, processing methods, and mechanical properties. PUs have been used during the past thirty years in a variety of applications outstanding to their comfort, cost benefits, energy savings and etc. [1]. Nanocomposites are defined as a new class of materials by including at least one solid phase with nanometer dimension. The dispersing of inorganic magnetic nanoparticles into polymer matrix can provide high performance novel materials that find applications in many industrial fields and MNPs that provide high mechanical and morphological properties are good applicants for the preparation of PU nanocomposites. Also to enhance the performance of nanoparticle and increase the interaction between nanoparticle and polymer matrix, surface modification of nanoparticles is employed [2]. In this report, we sought to prepare magnetic PUR that can increase the functional application areas of PU and also improved some of its properties, especially, morphological structores. Nanocomposites were produced by an *in situ* method, whereas the MNPs/Silica/urea core-shell NPs were synthesized by sol-gel methods. MNPs were used in polymer formulation and the morphological properties of the nanocomposites were studied.

### 2. Experimental

### 2.1. General

Surface morphology of the nanoparticles and PU nanocomposites were investigated by SEM (VEGA/TESCAN). FT-IR spectra were recorded on a Shimadzu 8400S spectrophotometer. Iron (II) chloride tetrahydrate, iron (III) chloride hexahydrate, ammonia solution, ethanol, tetraethyl orthosilicate, chloropropyltrimethoxysilane, acetonitrile and toluene were purchased from Merck or Fluka and were used as received without further purification. The polyol used was a Polymok®-327 and the isocyanate moiety (MDI) were Isomok®-370 from Mokarrar Company and were chlorofluorocarbon free systems.

### 2.2. General procedure for preparation of modified MNPs and PUR nanocomposites

The MNPs and MNPs/silica nanoparticles were synthesized according to previous report [3]. Then 1 mL of chloropropyltrimethoxysilane was dissolved in toluene. This mixture was added to 1 g of MNPs/silica and the solution was stirred overnight and after that, collected and dried. The prepared nanoparticle was added to a solution of urea in acetonitrile in a round bottom flask and the mixture was stirred. The obtained magnetic nanoparticles (MNPS/Silica/urea) were collected, washed and dried. At the following, modified MNPs were dispersed in the polyol matrix(1 and 3%). The mixture was sonicated and then sample was mixed with isocyanate in a mold at 10:12 weight ratio. Finally, the samples were kept at room temperature for curing.

## 3. Results and Discussion

Figure 1, presented the FT-IR analysis of MNPs and Modified MNPs. As shown, in MNPS spectrum (a), the band at 570 $cm^{-1}$ is due to Fe-O bending vibration. In the FT-IR spectrum of MNPS/$SiO_2$/urea (b) the absorption bands at 732 and 1060 $cm^{-1}$ are due to symmetrical and asymmetrical stretching vibrations of Si-O-Si. The presence of propyl groups was appeared at about 2848, 2918 $cm^{-1}$ in the spectrum. The signal appeared 1608 $cm^{-1}$ region can be assigned to the N-H bending, and 1733 $cm^{-1}$ is due to C=O stretching of urea, too.

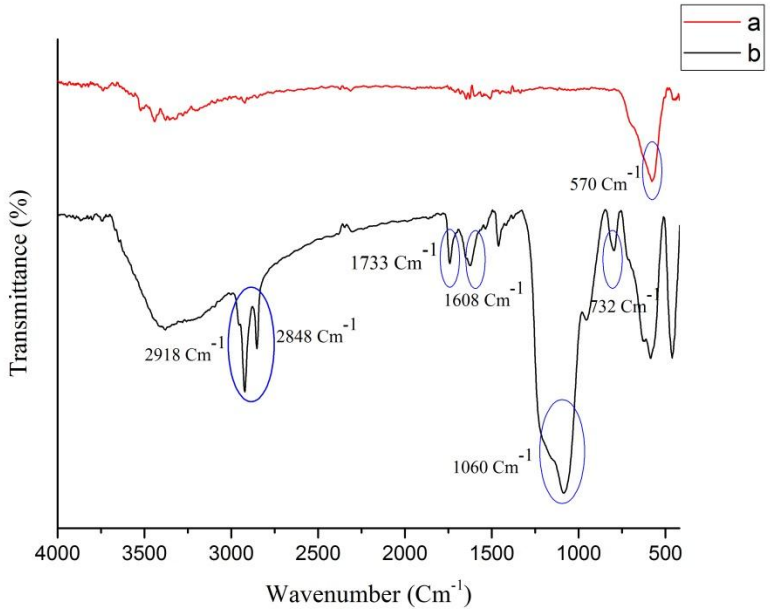



**Figure 1** FT-IR Spectra of magnetic nanoparticles (a) and modified MNPs (b)

Figure 2 showed the SEM image of synthesized modified Magnetic NPs.

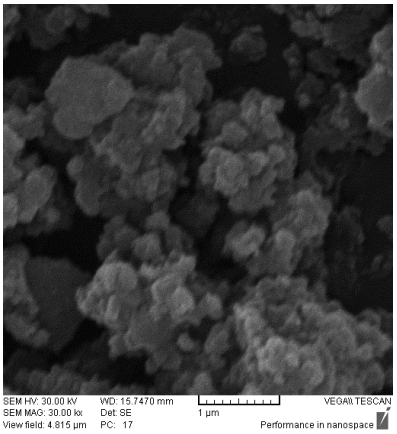


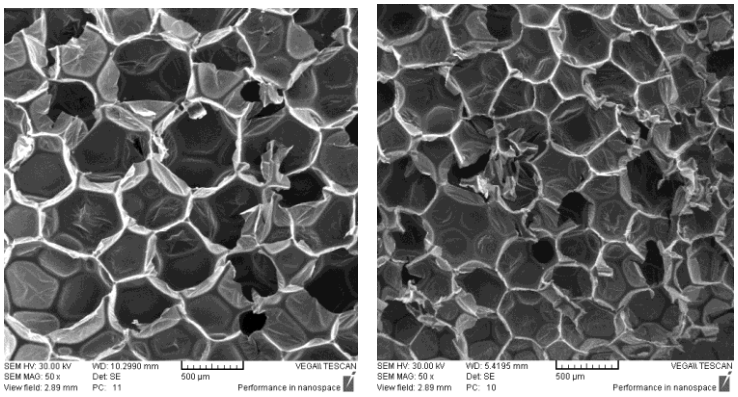

**Figure 2** SEM image of modified nanoparticles

Figure 3, are attribiuted to SEM images magnetic nanocomposites(1 and 3wt%). The cell density ($N_f$) is calculated by Equation (1) [1]. As shown in the figure, by increasing the content of the modified MNPs in polymer matrix (1wt% and 3wt%), cell density was increased and MNPs act as nucleation positions to help the bubble nucleation process during cell formation (Table 1).

$$N_f = \left(\frac{nM^2}{A}\right)^{\frac{3}{2}} \qquad (1)$$

**Table 1** Cell density of PUR

| Core-shell MNPs (%) | a (1) | b (3) |
|---|---|---|
| $N_f$ (cells/cm$^3$)×10$^5$ | 1.38 | 1.80 |




**(a)** **(b)**

**Figure 3** SEM images of Magnetic nanocomposites (1 and 3 wt%)

## 4. Conclusions

Magnetic PUR foam nanocomposites with different content of modified nanoparticles (1 and 3wt%) were prepared by in-situ polymerization method. Increase in modified MNPs content were affected the cellular structure of PU foam and Decrease the cell size, and increase the cell density, too.


## Aknowdgments

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