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Preparation And Characterization of Zeolite/ZnO Nanoparticle Obtained by Ion Exchange Method

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Abstract

In the present work Zeolite/ZnO Nanoparticle obtained by ion exchange method using Zinc Nitrate hexahydrate (Zn $(NO_3)_2$•$6H_2O$ as a precursor and distilled water were used as solvent. Comprehensive structural investigations were carried out using x-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR). XRD spectrum showed that the zinc oxide Nanoparticles exhibited crystalline structure. The sharp peaks in FTIR spectrum determined the purity of ZnO nanoparticles.

Keywords: Natural Zeolite, ZnO Nanoparticles. Ion exchange, XRD, FTIR.

Introduction

Metal oxide/zeolite nanostructures have been employed in catalytic processes for a variety of chemical reactions. These hybrid materials can be potential candidates for improved catalytic systems. Since zeolites as supports possess a generous surface area for high dispersion of Nano catalysts, well-defined arrays of channels and high porosity structure for maximum reactant contact, improve the electrical and structural properties of transition metal oxides to facilitate electron transport during chemical reactions and appropriate interaction of catalyst nanoparticles and the inorganic support for stable catalytic activity[1-2].

On the other hand, zinc oxide (ZnO) as a useful and efficient catalyst has been explored for organic conversions. In practical applications, the use of ZnO nanoparticles with a broad surface area has led to the development of their catalytic activities. However, these nanosized particles have limitations, including the problem of the separation of catalysts at the end of the processes and the aggregation of nanoparticles [3-5]. To solve these problems, one interesting alternative is using ZnO supported on inert or active materials like zeolites that improves the catalytic efficiency and shows easy recovery by simple filtration and avoidance of aggregation of metal oxide nanoparticles.

Materials and methods

In this work, all chemical materials were used without any further purification. $Zn(NO_3)_2$•$6H_2O$ Zinc nitrate hexahydrate supplied from Sigma Aldrich ,Natural Zeolite(Heulandite),99% Ethanol, 35% HCl.. Distilled water was used as a solvent medium.

Natural zeolite that was crushed with a grinder then washed with distilled water for 1 hour at room temperature using a magnetic stirrer. The etching solution of 0.01N HCl was made.
The solution of 5gm natural zeolite was carried out with the etching solution of 0.01N HCl at 26° temperature for 2 hour followed by washing with distilled water using magnetic stirrer. The natural zeolite was filtered and dried.

Preparation of ZnO/Zeolite Nano composite:

0.1M solution of Zn $(NO_3)_2$•$6H_2O$ (2.974gm) dissolved in 50 ml deionized water and make it 100ml solution.

The etched powder of natural zeolite taken as 5gm from etching in zinc nitrate hexahydrate solution. The reaction was carried out for 24 hours in a conical flask. The solution was filtered and dried. The XRD and FT-IR pattern was carried. The XRD pattern is as shown below.

Results and discussion:

X-rays diffraction (XRD) patterns of Natural Zeolite and Zeolite/ZnO Nanoparticle obtained by ion exchange methods are shown in figure (1) and (2) respectively. The pattern suggests that the zeolite/ZnO NPs are

mostly similar with the zeolite peaks. Moreover, new peaks appeared in the zeolite/ZnO NPs are belongs to the ZnO .The new peak appeared at 31.95° which assigned as (100) related to ZnO which are in accordance with ZnO [96-210-7060] while some other ZnO peaks cannot be observed in the XRD pattern of zeolite/ZnO NPs which means that ZnO NPs are confined inside the zeolite [6].

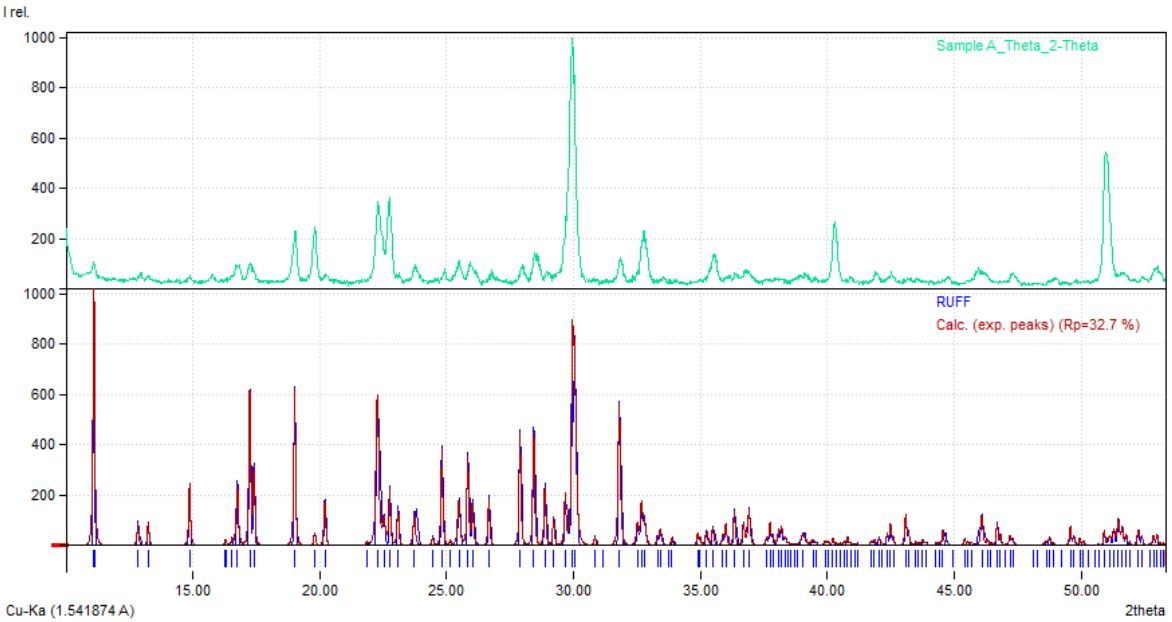

Fig.(1) XRD of Natural Zeolite

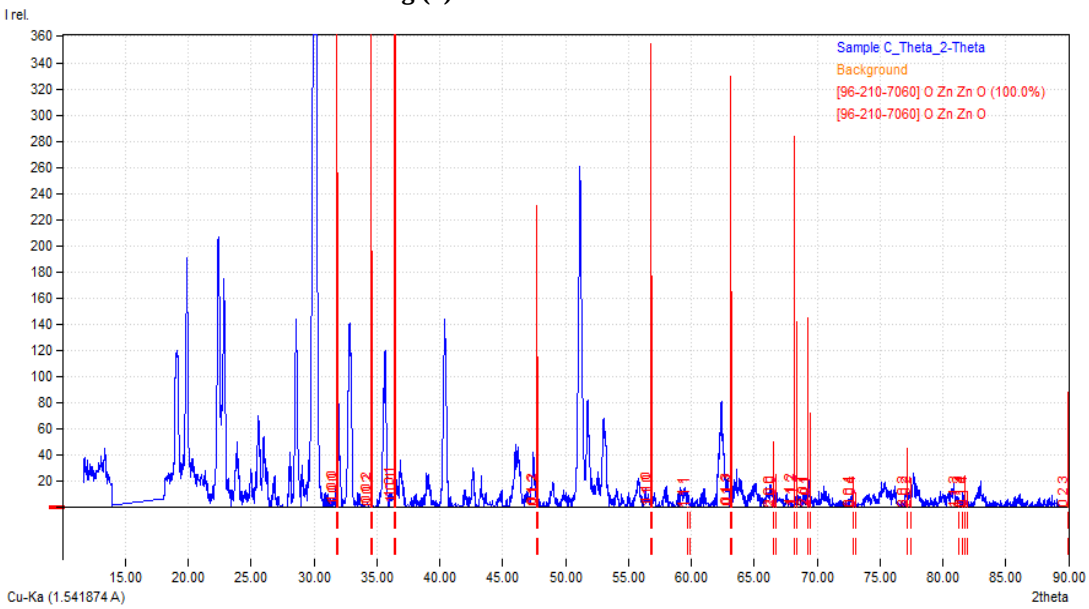

Fig.(2) XRD of Zeolite/ZnO Nanoparticles

Fig. 4 clarifies FT-IR spectra of prepared Zeolite/ZnO Nanoparticles. The vibration bands at 3515.42 cm-1 and 1629.92 cm-1 were assigned for O–H stretching due to the H2O interporous structure of O–H stretching (H bonding). The band at 994 cm-1 is due to the stretching vibration of Si–O, and the bands at 581–426 cm-1 for Si–O–Si bending vibration [7]. In general, comparing between the FT-IR spectrum of sample containing zinc oxide nanoparticles (Fig. 4B) with pure zeolite spectrum we can conclude that; small decrease in the peaks intensity,

broadening and shifting of the peak at 399 cm-1 to 395 cm-1 also evident for present of ZnO NPs and can be assigned to Zn–O bond in the ZnO NPs [8,9].

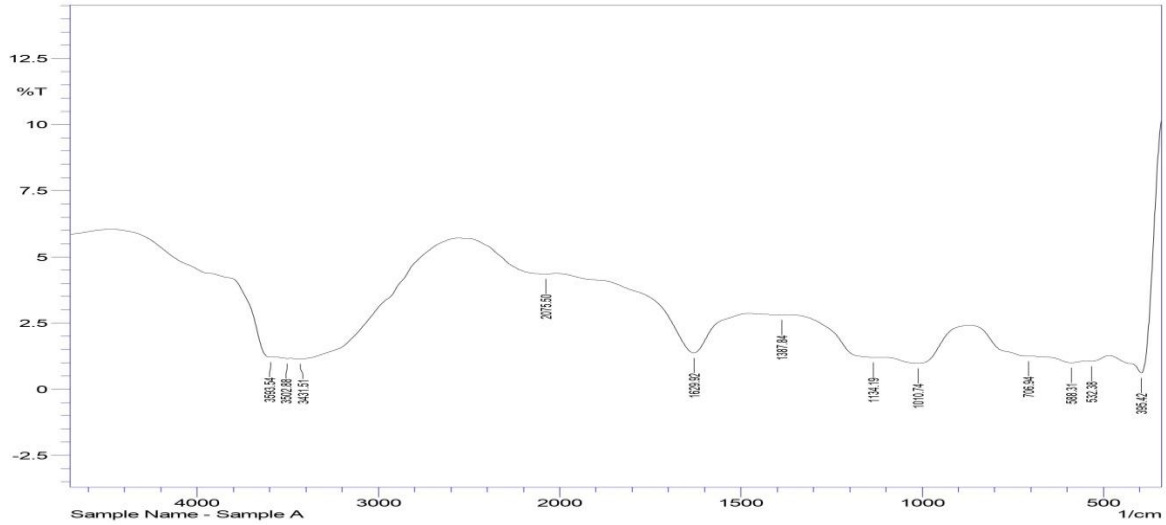

Fig.3 XRD of Natural zeolite

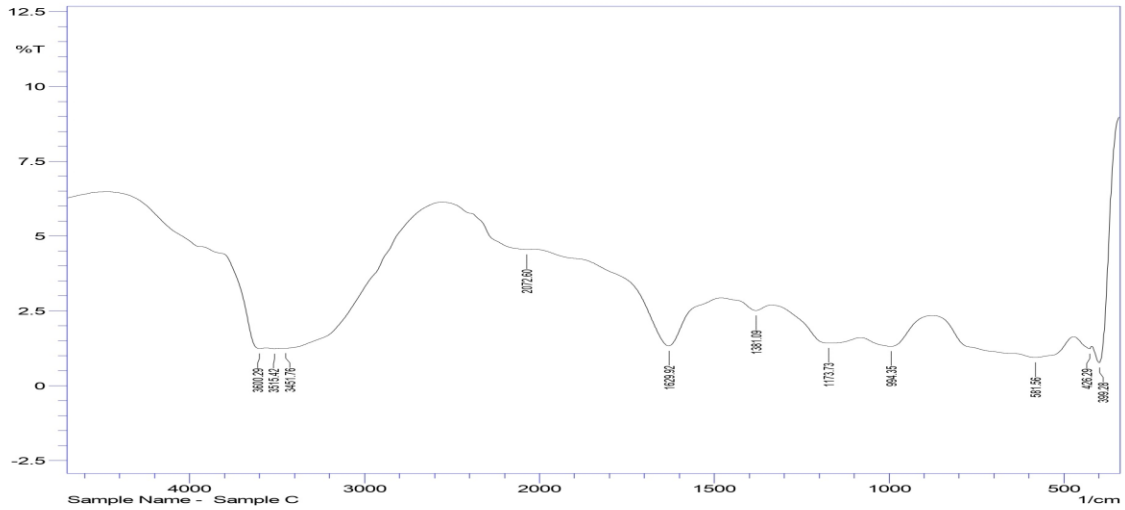

Fig. 4 FTIR of Zeolite/ZnO Nanoparticles

Conclusions:

In this present work, Zeolite/ZnO Nanoparticles (NPs) were successfully synthesized by ions exchange method and FTIR spectra confirm synthesis of Zeolite/ZnO NPs. The synthesized ZnO Nanoparticles obtained exhibit good crystallinity which was approved by XRD spectra,

Reference:

[1] A. Qurashi, M. Haffar, Z.H. Yamani, RSC Adv. 5 (2015) 22570.
[2] V.R. Batistela, L.Z. Fogac, S.L. Fávaro, W. Caetano, N.R. Fernandes-Machado, N. Hioka, Colloids Surf. A Physicochem. Eng. Asp. 513 (2017) 20.
[3] S.S. Katkar, P.H. Mohite, L.S. Gadekar, K.N. Vidhate, M.K. Lande, Chin. Chem. Lett. 21 (2010) 421.

[4] O. Sacco, V. Vaiano, M. Matarangolo, Sep. Purif. Technol. 193 (2018) 303.
[5] D. Singh, P. Patidar, A. Ganesh, S. Mahajani, Ind. Eng. Chem. Res. 52 (2013) 14776.
[6] C. Bouvy, W. Marine, R sporken, B. L. SU.Chemical Physics Letters428 (2006)
[7] Shameli K, Ahmad MB, Zargar M, Yunus W, Ibrahim NA. Int J Nanomed 2011;6:331–41.
[8] Lihitkar P, Violet S, Shirolkar M, Singh J, Srivastava O, Naik R, Kulkarni S. Mater Chem Phys 2012;133:850–6.
[9] Al-Hada NM, Saion EB, Shaari AH, Kamarudin MA, Flaifel MH, Ahmad SH, Gene SA. PloS One (2014).