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RESEARCH ARTICLE :

Characterization of nano-gypsum through nanotechnological approach

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SUMMARY : Nanotechnology deals with small particles with the dimension of 1-100 nm (one billionth of a metre). These particles have high surface mass ratio and are capable of improving the agricultural inputs including gypsum. A study on characterization of Nano-gypsum through nanotech equipments was conducted. The Nano-gypsum was characterized with SEM, XRD, FTIR and raman Spectrometer. It was conformed that the nano-clay has attached with gypsum. After loading of gypsum on Nano-clay, the surface morphology of nano-gypsum was transformed to clustered in shape and the XRD patterns, Raman spectra and FTIR of the Nano-gypsum was changed in the peak angles. This study was conformed that the nano- clay has loaded with nano- gypsum.

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KEY WORDS :
SEM, XRD, FTIR, Raman spectram

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BACKGROUND AND OBJECTIVES

Nanotechnology applications in agriculture are gradually transforming the theoretical possibilities into the practical applications. The potential is increasing with suitable techniques and sensors being identified for precision agriculture, natural resource management, early detection of pathogens and contaminants in food products, efficient delivery systems for agrochemicals such as fertilizers and pesticides, improved systems integration for food processing, packaging and other areas like monitoring agricultural and food system security (Subramanian and Tarafdar, 2011). The role of nanotechnology in soil remediation/ reclamation is yet to be attempted.

Objectives :
- To study the morphological characteristics of nano-gypsum
- To find out the attachment of gypsum on nano-clay

RESOURCES AND METHODS

The present research work was aimed to synthesise nano-gypsum locally in the Department of Nano Science and Technology, Tamil Nadu Agricultural University and to study its role on the reclamation of sodic soil for rice crop. The Nano-gypsum samples were characterized Nano-clay loaded with gypsum or in composite formulation was placed in the specimen chamber and mounted rigidly on a specimen holder called a specimen stub.

The SEM used for the analysis (FEI, Quanta 200, Netherland) for taking images of nano-clay samples. About 50 to 100 mg of nano-clay sample was dusted on the carbon conducting tape. Then the tape was mounted on sample stage and the images were taken in 16,000 magnification and 12.50KV. The Raman spectrum was measured for the nano clay loaded with or without gypsum. Raman spectroscopy used for measurement was Raman spectrum Model- R-3000-QE. The powder dried sample kept in a polythene bag was spread to an extent of 1 cm^2 and Raman probe was placed on the sample pockets without exposing the sample directly to the probe. Approximately one gram of nano clay loaded with or without gypsum was dusted on a glass substrate. Care was taken that the surface on the glass substrate is even, then the false substrate was mounted on the sample stage and diffraction was measured. nano-clay loaded with or without gypsum and IR transparent material like KBr was mixed in the ratio of 2:1 in a mortar and pestle for 30 minutes. Then the mixture was converted into pellets by pressing the prepared mixture with a hydraulic or hand press into a hard disk. The pellet, ideally 0.5 to 1 mm thick was then placed in a transmission holder and scanned. Typically, the pellet technique provides good quality spectra with a wide spectral range and no interfering absorbance bands.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads :

SEM images :

The surface morphology of nano clay (montmorillonite) before (Plate 1a) and after loading with gypsum (Plate 1b) was examined under SEM. The result showed that nano-gypsum is very clustered and consolidated compared to the substrate, nano-clay (montmorillonite) which is scattered and sparse. The characteristics of nano-gypsum performed using high resolution microscope *viz.*, SEM and spectroscopies clearly indicated the successful synthesis of nano-gypsum. The SEM image of nano-gypsum was clustered and consolidated while it's carrier, nano-montmorillionite is scattered and sparse.

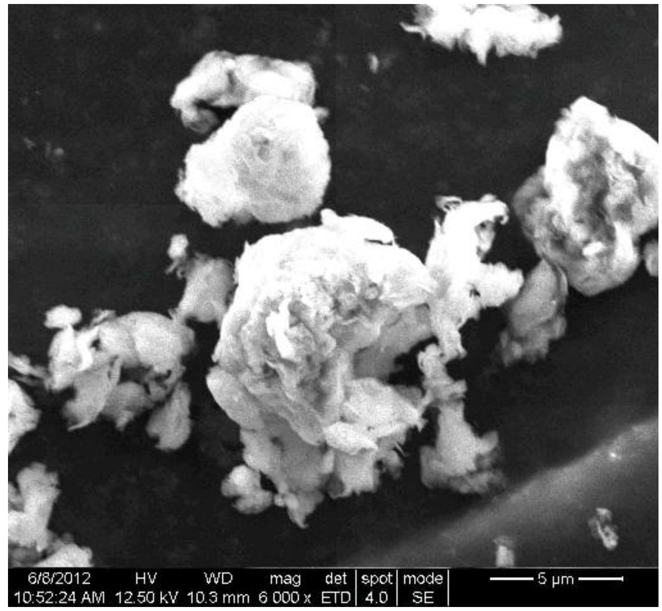

Plate 1(a): SEM image of nano-clay before loading gypsum

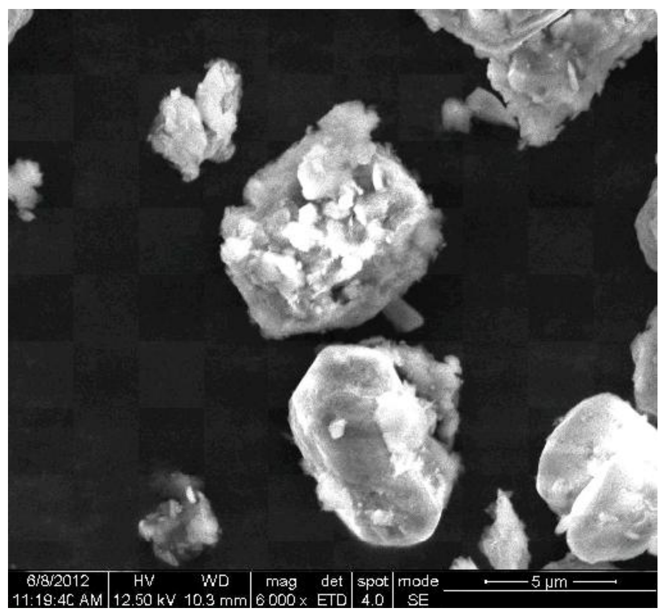

Plate 1(b): SEM image of nano-clay after loading gypsum

X-Ray diffraction :

The XRD pattern of nano-clay (montmorillonite) before and after loading gypsum is given in Fig. 1. The peaks at 2θ was observed for pure nano-clay (montmorillonite). When it was loaded with gypsum, there was a change in peaks 2θ and in the peak angle. These peaks clearly showed that gypsum was attached on nano-clay similar works was done by (Bish and Post, 1989).

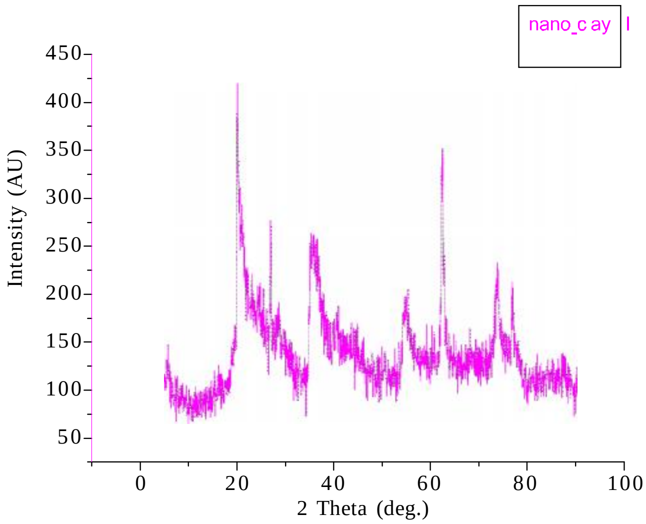

Fig. 1(a): XRD pattern of nano-clay

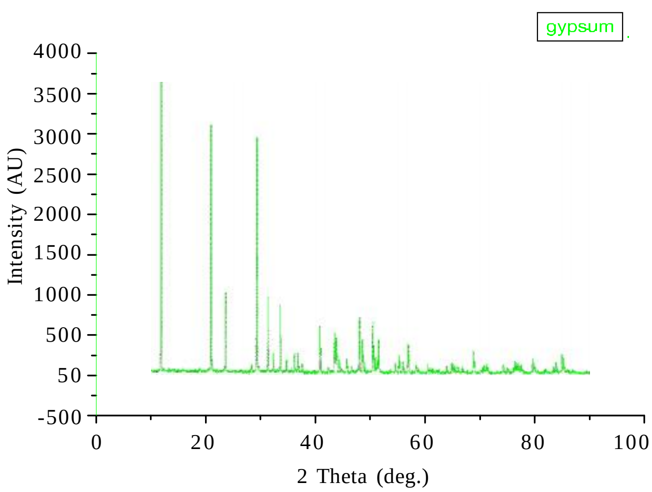

Fig. 1(b): XRD pattern of gypsum

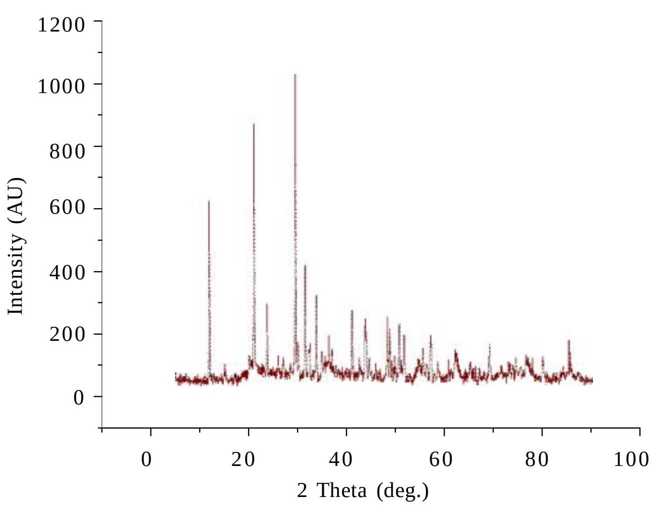

Fig. 1(c): XRD pattern of nano-clay loaded with gypsum

Raman spectrum :

The Raman spectrum studied for the nano-clay (montmorillonite) unloaded and loaded with gypsum is given in Fig. 2. The relative intensities of the peaks were used to quantify the information on the composition of a mixture. The intensity of peaks for unloaded nano-clay (montmorillonite) were 266.6, 1643.1, 1690.8, 1742.8 and 1781.0 cm^{-1} (Fig. 2a.). Gypsum carried the prominent peaks *viz.*, 1006.5, 1034.5 and 1156.0 cm^{-1} (Fig. 2b).

The same way, the peaks for nano-clay (montmorillionite) loaded with gypsum were 271.70, 1006.3, 1644.9, 1690.0, 1742.80, and 1781.0 cm^{-1} (Fig. 2c) which confirmed the gypsum attachment with nano-clay supported the facts (Schradar, 1995).

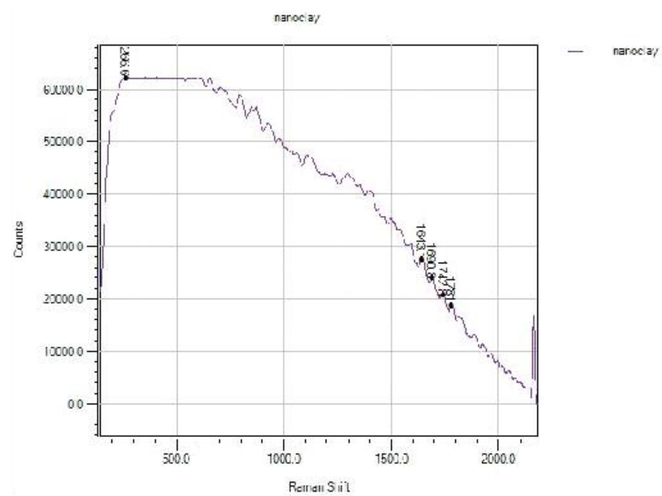

Fig. 2(a): Raman spectra of nano-clay before loading gypsum

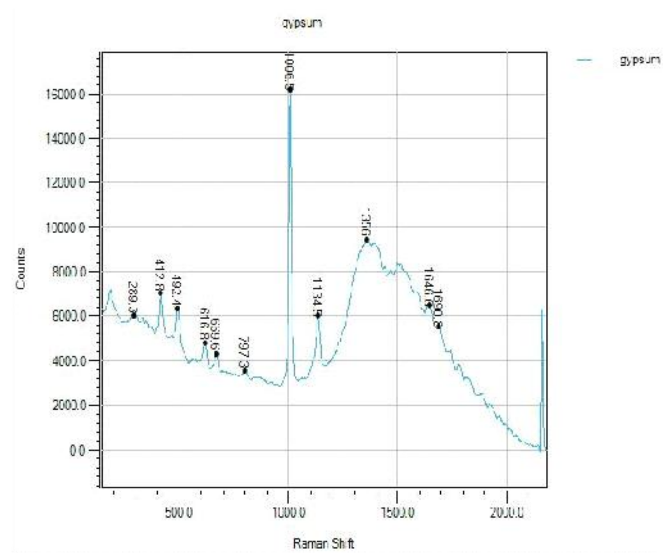

Fig. 2(b): Raman spectra of gypsum

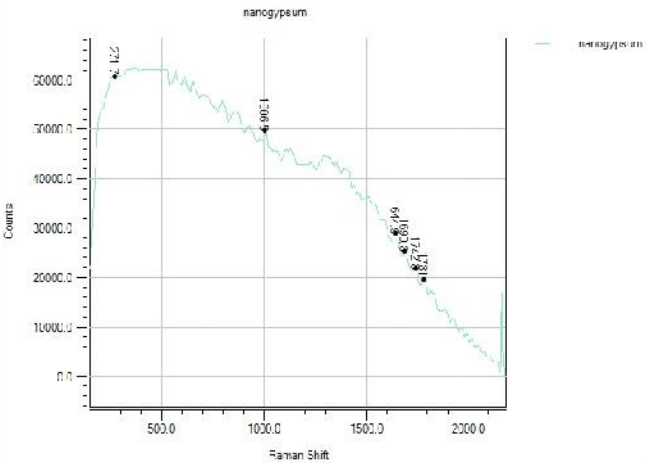

Fig. 2(c): Raman spectra of nano-clay after loading gypsum

FT-IR Spectra :

The data were confirmed with FT-IR spectra which are given in the Fig. 3.

The IR spectra of unloaded nano-clay (montmorillonite) is given in Fig. 3a. which has characteristic peaks of 3635.16, 2919.70, 1836.86, 1641.13, 1471.42, 1126.22, 799.35, 722.21, 625.79, 435.83 and 407.87 cm^{-1}. The IR spectra of gypsum (Fig. 3b) indicated that it had characteristic peaks of 3306.36, 2237.02, 1686.44, 1626.66, 1237.11, 671.11, 605.54 and 428.12 cm^{-1}. The IR spectra of nano-clay (montmorillonite) loaded with gypsum (Fig. 3c) have characteristic peaks of 3405.67, 2920.66, 2851.24, 2238.95, 1623.77, 1470.46, 1172.51, 799.35, 666.29, 600.72, 528.40 and 420.41 cm^{-1}. There was a shift in the peaks after loading of gypsum. This confirmed that gypsum is attached into nano-clay (montmorillonite) above findings are in line with the findings of Smith, 1999.

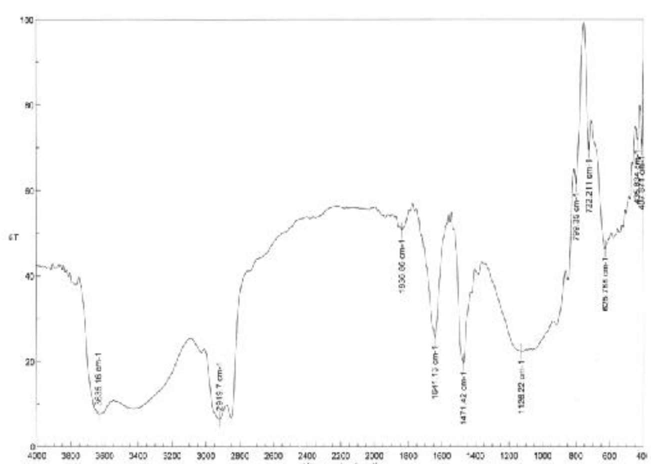

Fig. 3(a): Raman spectra of nano-clay after loading gypsum

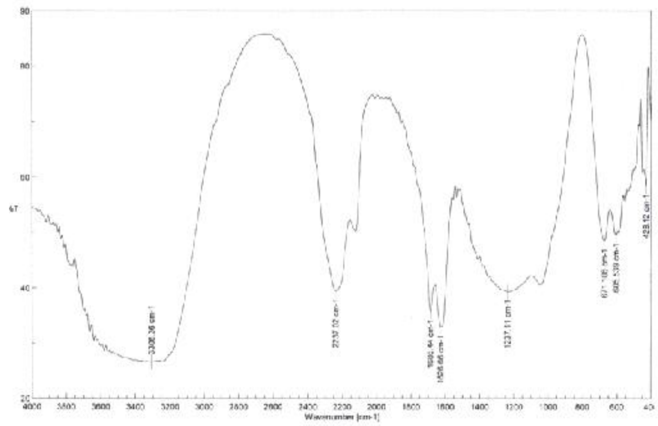

Fig. 3(b): FT-IR spectra of gypsum

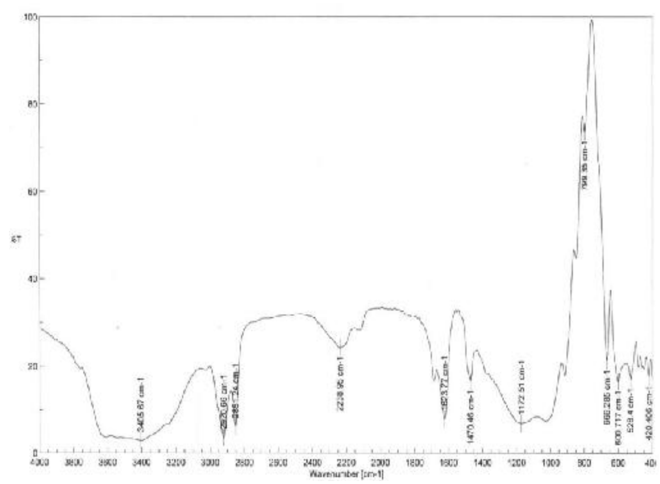

Fig. 3(c): FT-IR spectra of nano-clay after loading with gypsum

Conclusion :

It is concluded that the Raman spectra and FTIR which measures the functional groups of nano materials have confirmed the presence of gypsum loaded into the nano-montmorillionite as depicted by the presence of functional groups. Further, the XRD picture showed the reduction in d-spacing that coincide with ion attachment between the lattices. The SEM image of nano-gypsum was clustered and consolidated while it's carrier, nano-montmorillionite is scattered and sparse.

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