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Investigation of Various Properties of Intrinsic and Extrinsic Mgo2 Nanomaterials Doped With Neodymium

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ABSTRACT:-
Magnesium oxides (MgO_2) have attracted considerable interests due to their unique physical and chemical properties and wide applications in catalysis, ion exchange, molecular adsorption, biosensor, and energy storage. In the present investigation, we synthesize intrinsic and extrinsic MgO_2 nanofilm on glass substrates using chemical dip method. MgO_2 was doped with different dopant concentration (0%, 0.1%, 1% and 10%) of Neodymium and thin films of it was also made using chemical dip method. MgO_2nanofilms are synthesized using chemical dip method because this method is environmentally as well as economically friendly as compared to other methods. Structure and morphology of materials were determined using X-ray diffraction (XRD), Scanning electron microscope (SEM), UV-Visible spectroscopy (UV-Vis.) and particle thickness by ellipsometery spectroscopy. The XRD pattern showed that MgO_2 nano material thin films and thin films of material doped with Neodymium were of amorphous in nature. UV-Visible spectroscopy is used to measure the optical properties. Reflectance spectra of these samples were carried out in the range of 200-800nm at room temperature. Optical band studies show that the films are highly transparent and exhibit a direct band gap. Band gap of as prepared nanomaterials and doped nanomaterials is investigated using tauc plot. The bandgap of pure MgO_2 thin films has been found to be lie in the range of 3.875 eV. The band gap of MgO_2 thin film increases on doping with Neodymium. Thickness of the prepared nanomaterial MgO_2 and with doped Neodymium thin films on glass substrate were carried out by ellipsometery spectroscopy. It was observed that the thickness of the thin films decreases on doping with Neodymium. SEM images of as prepared pure and rare earth metal Nd doped MgO2 nanoparticles on glass substrates were taken at different magnification and resolution. SEM images of pure MgO_2 thin films shows grains are of uniform shape whereas on doping with Neodymium, sem shows irregular shape. This study would provide to us useful information about the changes in physical properties when we dope MgO_2 with Neodymium.

Key Words: - Extrinsic, nanofilm, dip coating method,

INTRODUCTION:

Magnisum oxides (MgO_2) have attracted considerable interests due to their unique physical and chemical properties and wide applications in catalysis, ion exchange, molecular adsorption, biosensor, and energy storage. Abundant techniques have been also developed to prepare nanoparticles of MgO. This nanoparticle has attracted much attention due to its wide band gap.[1-3]. In the recent years, various nanostructured Magnisum oxides, including one-dimensional (1-D) (nanorodes, nanowires, nanobelts, nanoneedles, and nanotubes), two-dimensional (2-D) (nanosheets, nanoflakes), and three-dimentional (3-D) (nanospheres, nanoflowers, hollowurchins) nanostructures and nontoxic. They possess high purity, high hardness and a high melting point. Magnesium oxide nanoparticles appear in white powder form.Magnesium oxide is obtained mainly by thermal decomposition of magnesium hydroxide or carbonate and recently by the sol–gel process. [4-5] The oxide morphology and particle size depend on the preparation conditions (pH, gelling agent, calcinations rate and temperature).It has been documented that methoxide or alkoxide based on the sol–gel synthesis of metal hydroxides followed by supercritical drying and vacuum dehydration can lead to the formation of small nanocrystalsor nanoparticles of metal oxides. In the present investigation MgO_2 nanofilms are synthesized using chemical dip method because this method is environmentally as well as economically friendly as compared to other methods. Also this method yields better thickness of nanofilm on glass substrate.

Experimental:-

Magnesium acetate (A.R.) and polyvinylpyrrolidone (PVP) were purchased from Himedia. For the preparation of mixture solution, deionised water was used.

MATERIALS AND METHODS:-

Magnesium acetate was used as magnesium precursor. The weight ratios of magnesium metal salt to PVP were 1:5. The glass slide is sonicated in a sonic bath. The substrate (glass slide) is immersed in the sol of as prepared coating material at a constant uniform speed. After 24 hours substrate is pulled up with same uniform speed. The speed determines the thickness of the coating. Faster withdrawal gives thicker coating of material. Film deposition was carried out in air at room temperature. The glass substrate is placed in vacuum oven for drying the film at 60 °C for 10 min. and then allowed to cool to room temperature. X-ray Diffraction studies have been carried out using PANalytical X-ray diffractometer. Surface morphology of the samples was studied using JEOL JSM 6510 scanning electron microscope. Optical characterization of the films was carried out using Hitachi 330 model UV-Vis. Spectrophotometer.

RESULTS AND DISCUSSION:-

1. XRD: - Figure 1 (a-d) shows X-ray diffraction pattern of MgO2 thin films with different do pant concentration of Neodymium (0%, 0.1%, 1% and 10%). The diffraction pattern shows that the prepared films of MgO2 nanofilm and with doped Neodymium with different concentration (0%, 0.1%, 1% and 10%) are all of amorphous in nature.

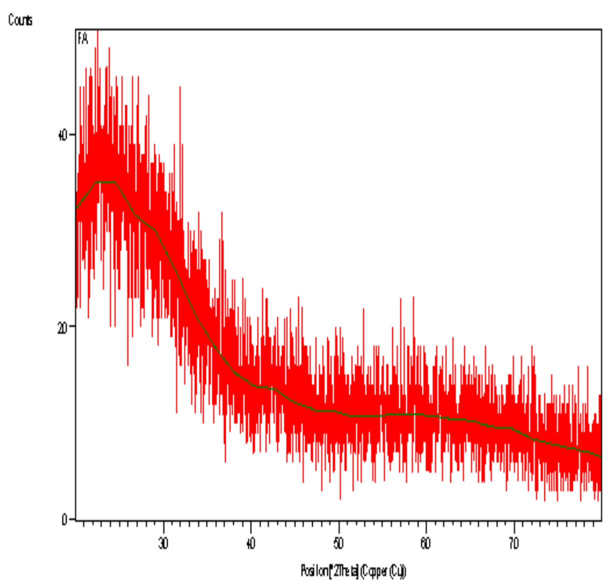


Fig. 1(a) XRD OF PURE MgO2

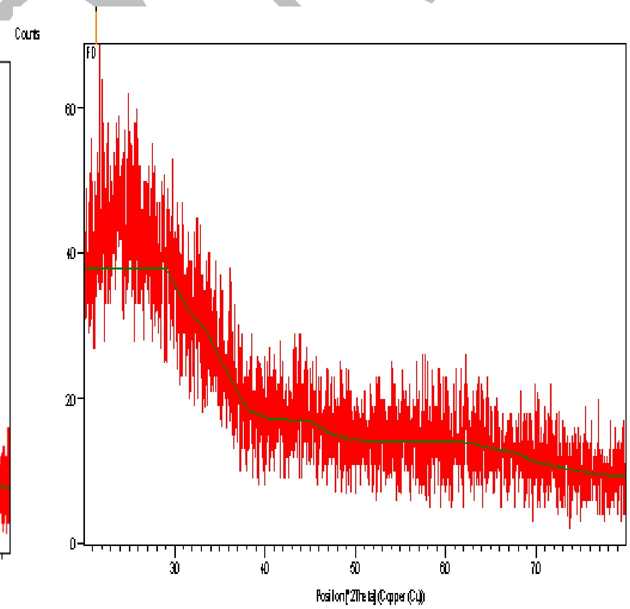
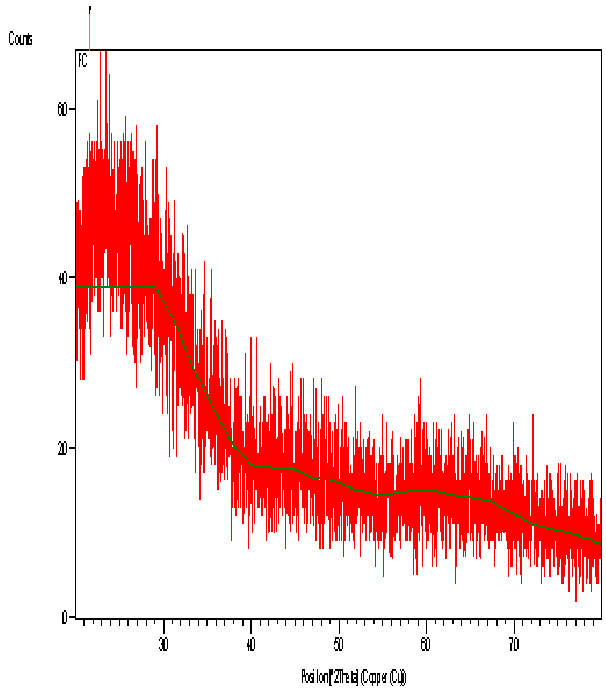


Fig. 1(b) XRD OF 0.1% Nd doped MgO2



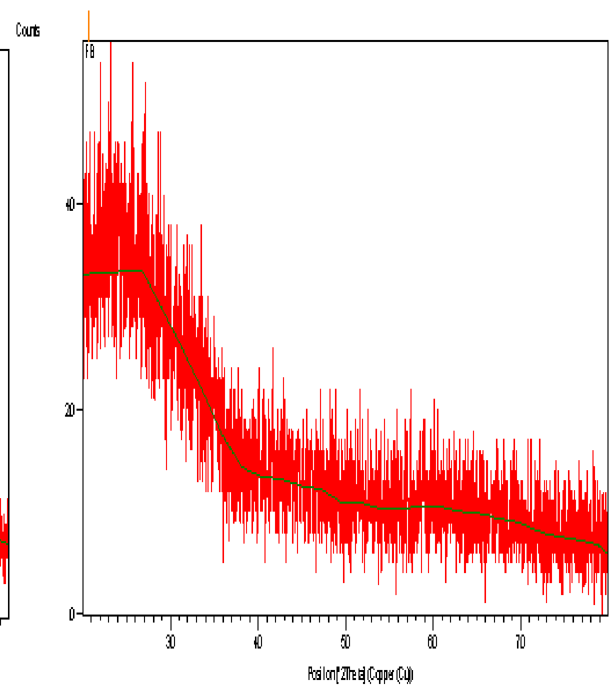


Fig. 1(c) XRD OF 1% Nd doped MgO2 nano film Fig. 1(d) XRD OF 10% Nd doped MgO2 film

1.1 ELLIPSOMETRY SPECTROSCOPY:-

Ellipsometry spectroscopy is done to measure the thickness of as prepared nanomaterial. Thickness for MgO2 nanoparticles prepared on glass substrate comes out to be 619.04 nm (Error: ±4.20 A°) and those for synthesized on glass substrate with 10 % Nd dopant is 517.24 nm (Error: ±0.023 A°) Whereas thickness of 1% Nd doped MgO2 nanofilm is 157.18± 1.313 A^0 and thickness of 0.1% Nd doped MgO2 nanofilm comes out to be 180.28± 3.17 A^0

Sample	Thickness (nm)	Error (A°)
Undoped MgO2	619.04	±4.20
MgO2 + 10% Nd	517.24	±0.023
MgO2 + 1% Nd	157.18	± 1.313
MgO2 + 0.1% Nd	180.28	±3.17

Table 1: Thickness of intrinsic and extrinsic (Nd doped) MgO2 nano films

Thus it is seen that on doping MgO2 with Neodymium, thin film thickness decreases and also with increasing concentration of dopant , the thickness of thin film again increases.

2. UV-VISIBLE SPECTROSCOPY:-

UV-Visible spectroscopy is used to measure the optical properties. Reflectance spectra of these samples were carried out in the range of 200-800nm at room temperature as shown in fig. 2. Reflectance spectra show three absorption peaks. First absorption peaks appeared at around 310 nm which is blue shifted to undoped MgO2. On increasing the dopant concentration, the spectra shifted towards lower wavelength which indicate that bandgap increases on increasing the Nd concentration. This behaviour is explained by the Burstien-Moss effect [6-7]. Band gap of as prepared nanomaterials is investigated using tauc plot. It has been found that band gap of as prepared nanomaterials is 3.875 eV for intrinsic MgO_2 and when we dope MgO2 with Neodymium, the band gap increases. The band gap is around 4.0 eV for extrinsic MgO_2

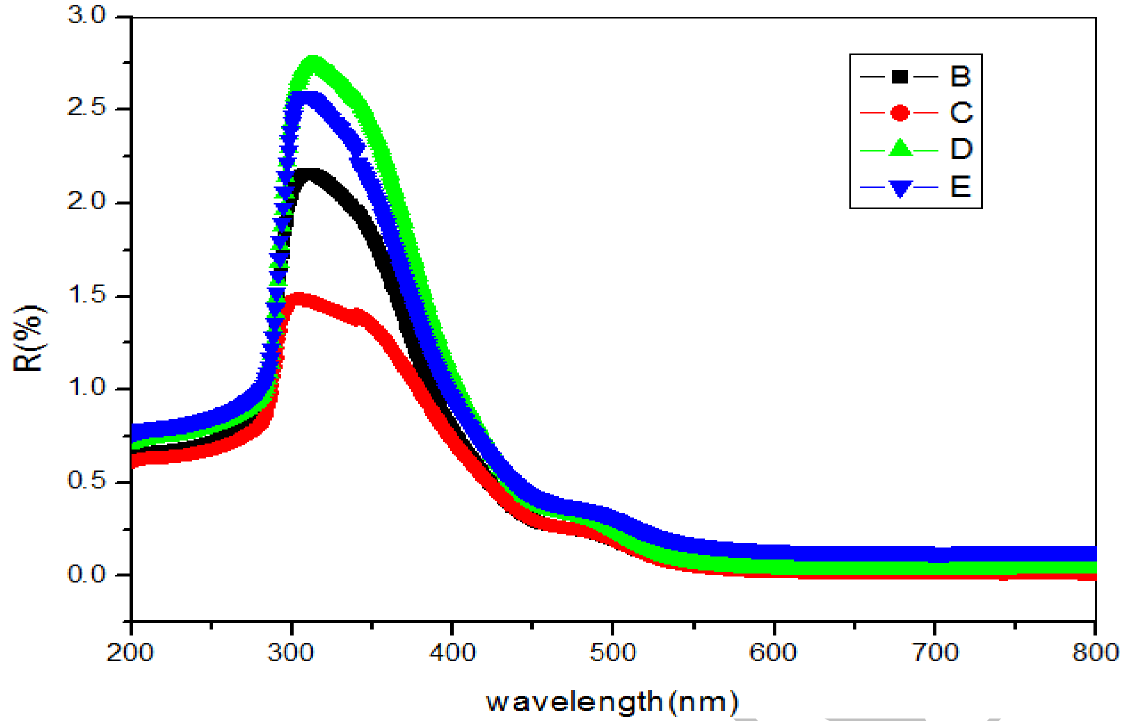
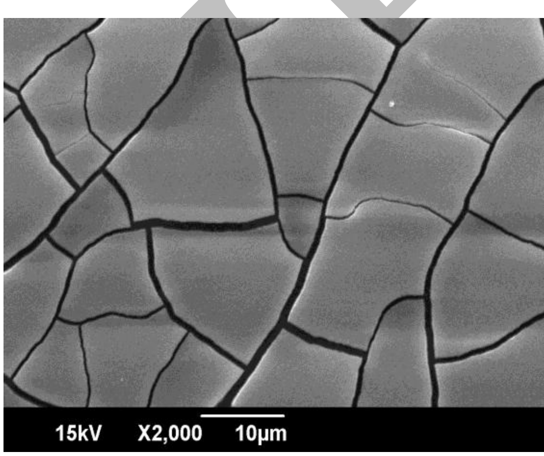


Fig.2) UV-Visible spectra of intrinsic (b) and extrinsic (c-e) MgO2 nanomaterials doped with 0.1,1,10 % Neodymium

3. Scanning Electron Microscopy (SEM):-The SEM is used to produce high- resolution imaginings of shapes of substances and to confirm spatial variations in chemical compositions. Fig.3(a-h) shows SEM images of as prepared pure and rare earth metal Nd doped MgO2 nanoparticles on glass substrates at different different magnification and resolution. The images show a general view of the morphology of as prepared nanomaterials. The morphology of pure nanomaterials reveals that they are uniform in shape but as doping concenteration increases they have irregular shape.



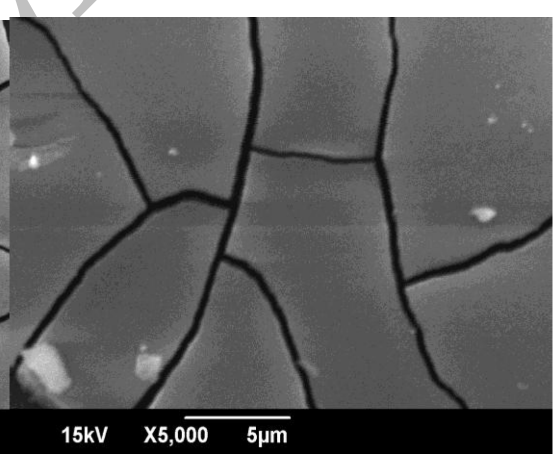


Fig. 3(a) SEM of pure MgO2 nanomaterial at 2000XFig. 3(b) SEM OF pure MgO2 nanomaterial at 5000X

Fig. 3 (c)

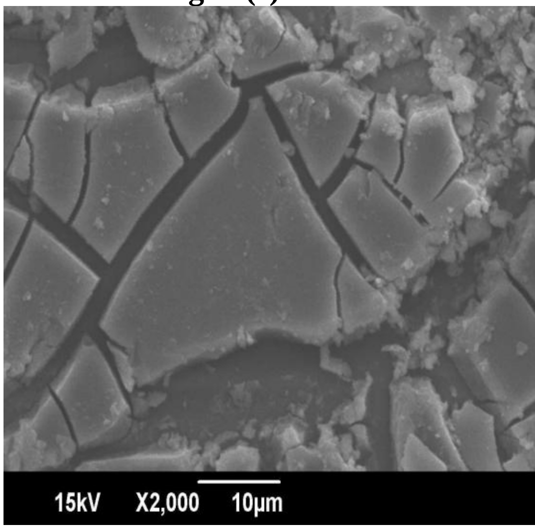


Fig. 3 (d)

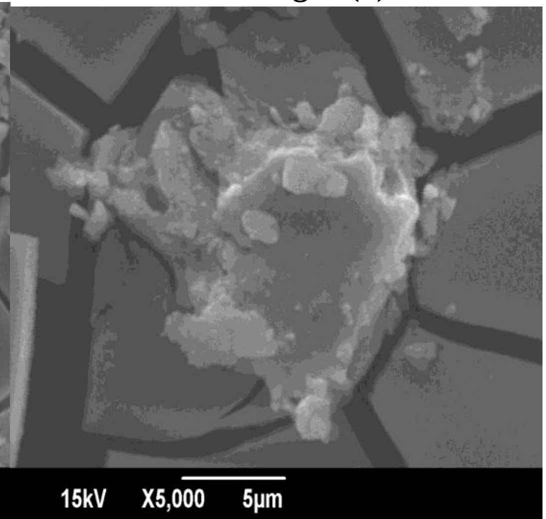


Fig. 3(c) SEM of 0.1% Nd doped MgO2 nanomaterial at 2000XFig. 3(d) SEM of 0.1% Nd doped MgO2 nanomaterial at 5000X

Fig. 3 (e)

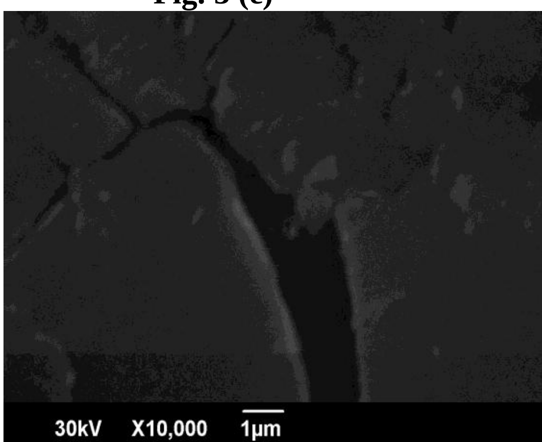


Fig. 3 (f)

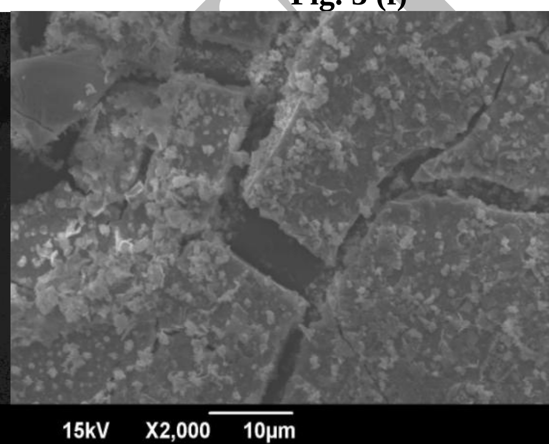


Fig. 3(e) SEM of 1% Nd doped MgO2 nanomaterial at 10,000XFig. 3(f) SEM of 1% Nd doped MgO2 nanomaterial at 2000X

Fig. 3 (g)

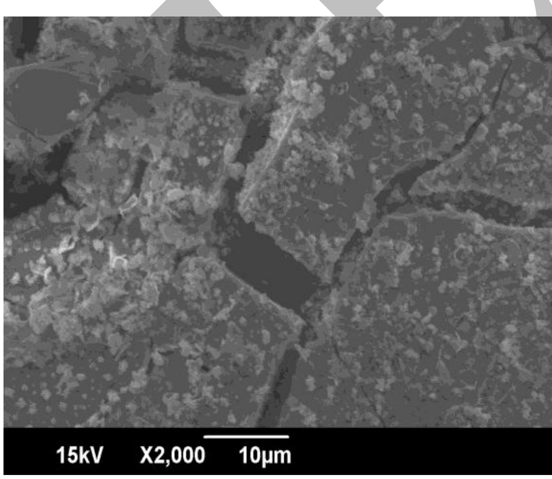


Fig. 3 (h)

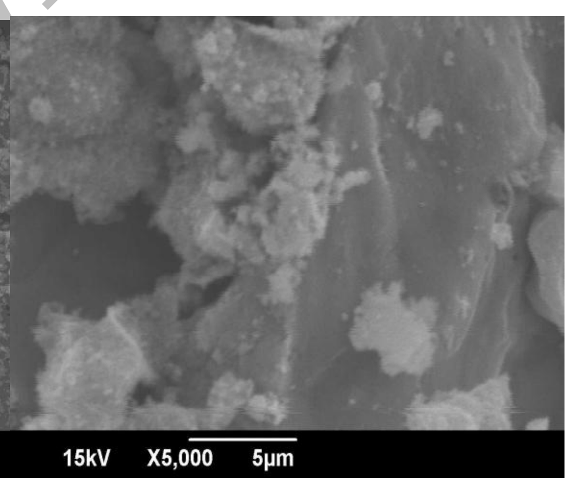


Fig. 3(g) SEM of 10% Nd doped MgO2 nanomaterial at 2,000XFig. 3(h) SEM of 10% Nd doped MgO2 nanomaterial at 2,000X

4. CONCLUSION:-

Thin film of MgO2 nanoparticles has been prepared on glass substrate by dip coating method. X-ray diffraction analysis reveals that MgO2 film is in amorphous in nature. Reflectance spectra of these samples were carried out in the range of 200-800nm at room temperature. It has been found that band gap of as prepared nanomaterials is 3.875 eV for intrinsic MgO_2 and when we dope MgO2 with Neodymium , the band gap increases. The band gap is around 4.0 eV for extrinsic MgO_2. On doping MgO2 with Neodymium ,thin film thickness decreases and also with increasing concentration of dopant , the thickness of thin film again increases. SEM images shows that as prepared nanoparticles are uniform in shape and they form thick film on glass substrate, but on doping with Neodymium, nanoparticles are having irregular shape.

5. ACKNOWLEDGMENT:-

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