FABRICATION OF UNIT FOR NOx GAS SENSOR

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Abstract— The number of sensors which can detect various gas species has increased dramatically especially with respect to global issues of environment and earth atmosphere, the necessity of those gas sensors which can detect air pollutant such as NOx gases in environment is felt. They are essentially required in order to control the systems of combustion exhausted from industry, stationary facilities and automobiles. So it is necessary for the scientists to design and fabricate the gas sensors which are of low cost, selective, sensitive, and accurate especially in low level concentrations of target gases, easy to process and of high recovery and response time, good electrical properties, and above all tunable structure at the nano scale so we have studied and characterize a material for NOx gas sensor. A novel composite room temperature (RT) gas sensor based on a a-Ni(OH)2 thin nanosheet (TNS)/reduced graphene oxide composite (a-Ni(OH)2 TNS/rGO composites) was successfully synthesized via a hydrothermal process. Structural and morphological characterization of prepared materials are evaluated by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM).

Index Terms— Technologies to detect gas, detect air pollutant NOx, Fabricate gas sensor, Low cost, Hydrothermal process, XRD, FTIR, SEM.

1 INTRODUCTION

THE Gas sensor are electronic device that detect different types of gases, The detection of NOx gas, which is one of the most noxious, poisonous and abundant air pollutants, is of great importance from the viewpoint of both environmental protection and human health. The NOx sensors with excellent performance and their composites have been reported in the NOx gas is very hazardous gas and harmful to human health so we fabricate a NOx gas sensor by using hydrothermal method. Unfortunately, most of these devices are operated at higher temperatures and the further development of sensors was restricted. Therefore, many efforts are currently being made to develop sensors that can effectively detect NOx at RT. The sensor has to be very sensitive to pick up this level. The main challenges in the sensor development are selectivity, sensitivity, stability, reproducibility, response time, limit of detection and cost. The sensing characteristics of such sensors can be optimized by controlling their morphology, surface to volume ratio, and electrical properties. The developments in nanotechnology, fabrication methods, and synthesis provide a suitable atmosphere to construct those sensors with their mentioned sensing characteristics easier. The structures and compositions of the as-prepared products were characterized by XRD and FTIR spectra. The morphologies of the synthesized samples were studied by SEM and transmission electron microscopy. At present, the materials used for fabricating chemical gas sensors are mostly nanostructured metal oxides with semiconducting characteristics. Researchers (Niederberger, Gurlo, Barsan and Koziejet et al.) have synthesized various sensitive materials (SnO2, In2O3, ZnO, WO3 etc.) with high sensitivities and fast responses to hazardous gases. Their enhanced sensing properties are determined by the high chemical activity and porosity of the materials, which are a direct consequence of their nanostructure.11 Therefore, porous sensing materials which can satisfy these demands attract much attention, not only for their inherent chemical activity but also due to the existence of excellent channels for the mass transportation of the target gases and as they can provide more adsorption sites for gas molecules. In recent years, metal oxide nanomaterials, for instance ZnO,12–14 In2O3, 15–17 SnO2, 18–20 WO3 21,22 etc., and particularly those with 3D hierarchical structures have been successfully prepared and applied in the detection of NOx, CO, C2H5OH and other organic gas.

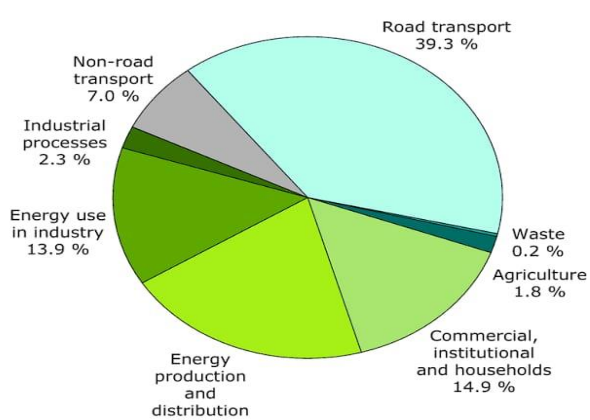

Fig : Pie chart showing NOx emission

Nitrogen oxide (NOx): Chemical compound of nitrogen &oxygen that is formed by reacting with Each other during combustion at high temp mainly combustion of fuel mainly oil, diesel, gas & organic matter. NOx is a common designation of nitrogen oxidenNO&NO2. The NOx sensor is part of the NOx reduction after treatment system used in diesel vehicles with urea-based SCR systems. The engine out NOx on a steady cruise is around 200-300 ppm. NOx gas is harmful to humans.

HYDROTHERMAL PROCESS:

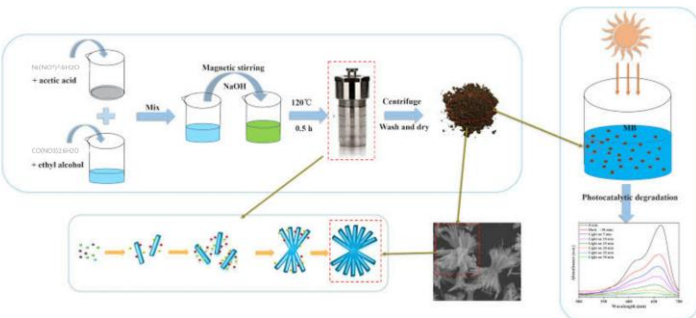

Fig : hydrothermal process

Hydrothermal synthesis includes the various techniques of crystallizing substances from high-temperature aqueous solutions at high vapor pressures; also termed "hydrothermal method". The term "hydrothermal" is of geologic origin. Geochemists and mineralogists have studied hydrothermal phase equilibria since the beginning of the twentieth century. George W. Morey at the Carnegie Institution and later, Percy W. Bridgman at Harvard University did much of the work to lay the foundations necessary to containment of reactive media in the temperature and pressure range where most of the hydrothermal work is conducted.

Hydrothermal synthesis can be defined as a method of synthesis of single crystals that depends on the solubility of minerals in hot water under high pressure. The crystal growth is performed in an apparatus consisting of a steel pressure vessel called an autoclave, in which a nutrient is supplied along with water. A temperature gradient is maintained between the opposite ends of the growth chamber. At the hotter end the nutrient solute dissolves, while at the cooler end it is deposited on a seed crystal, growing the desired crystal.

ADVANTAGES- advantages of the hydrothermal method over other types of crystal growth include the ability to create crystalline phases which are not stable at the melting point. Also, materials which have a high vapor pressure near their melting points can be grown by the hydrothermal method. The method is also particularly suitable for the growth of large good-quality crystals while maintaining control over their composition. Disadvantages of the method include the need of expensive autoclaves, and the impossibility of observing the crystal as it grows if a steel tube is used. There are autoclaves made out of thick-walled glass, which can be used up to 300 °C and 10 bars.

Equipment for hydrothermal crystal growth- The crystallization vessels used are autoclaves. These are usually thick-walled steel cylinders with a hermetic seal which must withstand high temperatures and pressures for prolonged periods of time. Furthermore, the autoclave material must be inert with respect to the solvent. The closure is the most important element of the autoclave. Many designs have been developed for seals, the most famous being the Bridgman seal. In most cases, steel-corroding solutions are used in hydrothermal experiments. To prevent corrosion of the internal cavity of the autoclave, protective inserts are generally used.

3 EXPERIMENTATIONS:

$Ni(NO_3)_2.6H_2O$ =1.4 g , $Co(NO_3)_2.6H_2O$ = 0.72 g
HMT(hexamethylenetetramine) =4.54g, Ethylene Glycol (EG) = 25 ml.

Take a beaker and put 25 ml of EG in 10 ml of DI water then Put this solution on the magnetic starrier. Now put NI = 1.4 g, CO = 0.72 g HMT = 4.54 g in this solution and keep sterling for 30 min. Now, take a sample of RGO = 0.2g Put 0.2g RGO in 10ml of DI water and sonicate it for 15 min on ultrasonicate. then put this both the solution in Teflon autoclave. Now, firstly set an electric oven at 120 C, keep that solution which was in autoclave in oven, for 5 hrs. for 120 C. After 5 hrs. remove the solution from autoclave and wash that solution with. DI water in centrifuge with the help of plastic tubes Remove the material which is settle at bottom of tube in paper dash. After removal of material in a paper dash keep that paper dash in an electric oven.
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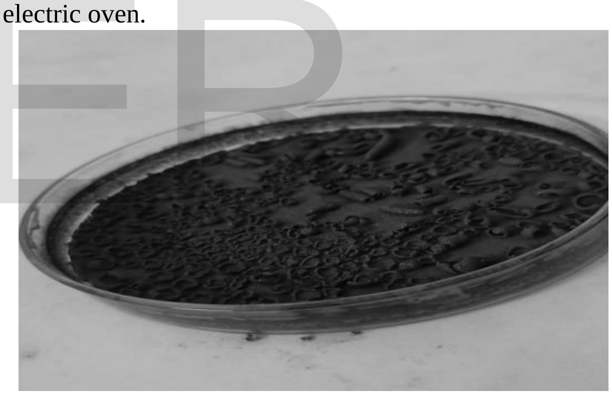


4 CHARACTERIZATION:

Characterizations is done by an several methods such as..

1. XRD – X Ray Diffraction
2. SEM – Scanning electron microscopy
3. BET – Brunauar Emmett teller
4. FTIR – Fourier transform infrared spectroscopy

Characterization outcomes:

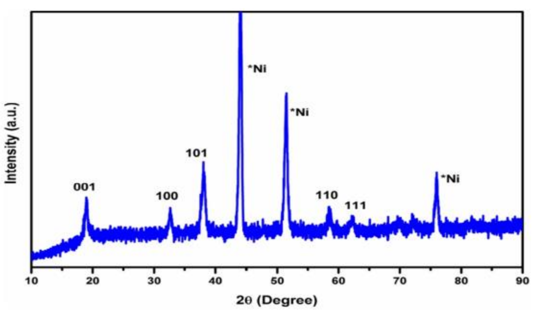
From XRD results confirm the material formation also gives the information about β-phase presence. The crystal size of 7-10 nm formed for Ni.Co-LDH/rGO composite (calculated from Sharers formula).

SEM imaged obtained for Ni.Co-LDH/rGO demonstrate the thickness of nanosheet (5-7nm) goes on decreases and finally converted into nanorods. SEM images also shows that required porous structure formed.

FTIR spectroscopy demonstrate the presence of –OH group supports XRD result formation of β-phase and hence more interlayer spacing which will beneficial for faster proton transport.

BET result exhibits specific surface area and pore size and for sample Ni.Co-LDH/rGO is higher surface area.

XRD patterns of the Ni.Co LDH/rGO (Ni:Co=2:1) are delineated in Fig.



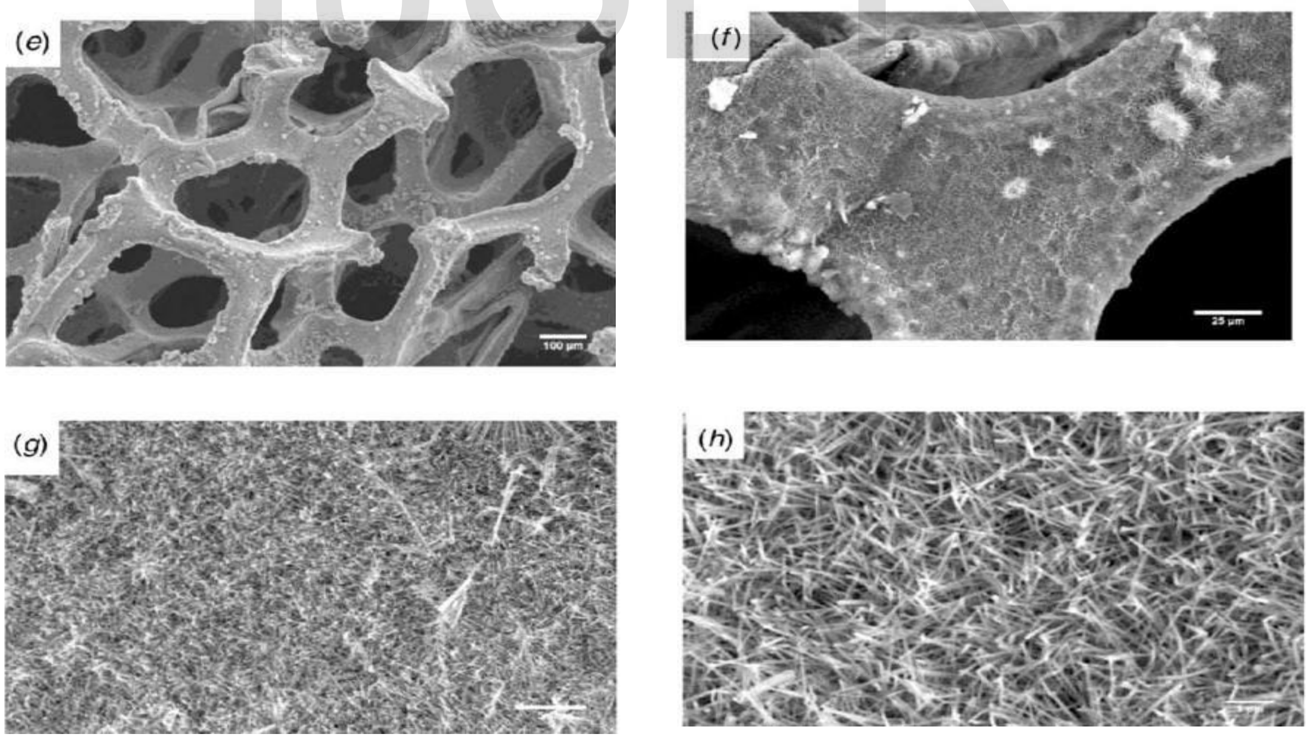
To investigate crystallographic structure and composition of the sample, XRD technique was used and the pattern is presented in Fig. 1. The diffraction peaks at two theta angles planes of Ni(OH)2 respectively. The remaining three high intensity peaks at two theta angle 44.30,51.50 and 76.040 indexed to and planes of metal Ni respectively.

angle 25.8 deg corresponding to the (002) plane were observed for rGO, but at further intensities this peak decreased in case of Ni(OH)2/rGO and Ni.Co LDH/rGO samples which suggest a decrease in restacking

When SEM images of Ni(OH)2/rGO having a nanoflower like structure were compared, it is observed that nanosheets are firstly connected to each other and form a porous structure, but nanosheets were further transitioned to a nanorod-like structure due to the addition of cobalt . The rGO sheet also showed uniform growth between the hydroxide sheet and such growth leads to an increase in the surface area.

Below SEM images shows of Ni(OH)2 chemically deposited on Ni foam. The nanosheets are interconnected formed flower-like structure. This flower-like structure consists of very smooth nano walls of thickness 50–70 nm thick with microporous 0.5–1 lm opening was observed. Due to such porous structure the space between nanoflower Ni(OH)2 nanosheets is efficiently utilized by allowing easy diffusion of electrolyte to the surface of active material.

SEM image of cross section of material deposited nickel foam, SEM images of Ni(OH)2/rGO deposited on Ni foam, and SEM images of the LDH/rGO nanocomposite deposited on Ni foa



The sharp XRD peaks at 2 θ

5 LITERATURE SURVEY:

Hongjie Wang, et al..[1] One step synthesis of hierarchical a-Ni(OH)2 flower like architecture and their gas sensing properties for NOx at room temperature-:Prepare through one step method & used simple reflux method. In this method gas sensing mechanism was discussed as tow aspects i.e. good responsibility & longer service life. DOI: 10.1039/c2ce25553g.

P.E. LOKHANDE, al..[2]: - Nanomaterial Based Supercapacitor-:A **supercapacitor** (**SC**), also called an **ultracapacitor**, is a high-capacity capacitor with a capacitance value much higher than other capacitors, but with lower voltage limits, that bridges the gap between electrolytic capacitors and rechargeable batteries. It typically stores 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerates many more charge and discharge cycles than rechargeable batteries, 6/17/2021.

Ying Yang, et al..[3] A novel gas sensor based on porous a-Ni(OH)2 ultrathin nanosheet/reduced graphene oxide composites for room temperature detection of NOx-:Used facile reflux method to synthesize a-Ni(OH)2. Excellent sensing performance as low direction limit of 970 ppb Short response time 9.0s Relatively high response of 64.9%. 2016, 40, 4678, DOI: 10.1039/c5nj03284a.

Rajesh Kumar, et al..[6] Zinc Oxide Nanostructures for NO2 Gas–Sensor Applications-: Because of the interesting & multi-functional properties' of ZnO nanostructure are considered as excellent material for fabrication of highly sensitive gas sensor. They discussed on NO2 gas sensor. Basic gas characteristic was also mentioned in this paper. utilization of ZnO & it's sensing stability & recyclability etc. are discussed in this article. (2015) 7(2):97–120, DOI 10.1007/s40820-014-0023-3.

M. Gardon • J. M. Guilemany,[7] A review on fabrication, sensing mechanisms and performance of metal oxide gas sensors-: Processes for developing layers onto a substrate as the active component of metal oxide gas sensors are presented and other promising alternatives as thermal spraying are also proposed. d the electrical signal is presented as determined by the influence of three main factors: the receptor function, the transducer function and the approachability. Distinct aspects for each key-step are discussed with the aim of achieving a better comprehension of the overall system. (2013) 24:1410–1421 DOI 10.1007/s10854-012-0974-4.

P.E. Lokhande, et al..[12] Nanoflower-like Ni(OH)2 synthesis with chemical bath deposition method for high performance electrochemical applications-: Faster development of electronic and automotive area demands power sources having a higher energy density, excellent power density and long-term durability. Recently supercapacitor attracted attention as a promising candidate for energy storage due to high power density, fast charge-discharge and long cycle life [1]. Present communication reports flower-like Ni(OH)2 nanostructure, synthesized by using simple and easy chemical bath deposition method on Ni foam. Materials Letters 218 (2018) 225–228.

The literature survey indicates that various nanomaterial are Studied by various investigator. It is suggested that morphology of nanostructure which have Unique mesoporous structure along with high specific surface Area are more efficient. It is evident from literature that different synthesis methods are. Used to synthesis the required nanostructure, which have good surface topography. Most of the research work is focused on the room temperature Sensor, and the response time of the sensor. Presently, catalysts, fuel cell and supercapacitor are considered as New areas of research and further studies are being done to get More efficient sensor.

6 CONCLUSION:

In the summary the nanostructure Ni.Co LDH/RGO composite successfully deposited on Ni foam by hydrothermal method for NOx sensor application. synthesized ultra-thin nanoshit of Ni. Co LDH/RGO showed on excellent sensing property to NOx GAS therefore, prepared composite material exhibits excellent sensitivity and fast response. In this study, a low cost and simple strategy was proposed to synthesize Ni. Co LDH/RGO. The obtained Ni.Co LDH/RGO displayed an excellent NO2 sensing performance at room temperature, which exhibited a high sensitivity, fast response time. The enhanced sensing performance of Ni. Co LDH/ORG nanocomposites for NO2 could be ascribed as the following reasons: the large surface area of mesoporous nanostructure provided the amount of adsorbed oxygen species, and active sites would facilitate gas diffusion channels to carrier diffusion/transportation and result in the faster response to NO2 at RT.

7 ACKNOWLEDGMENTS:

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