Testing the possibility of using epoxy-based composite materials reinforced with $CuSO_4$ powder to sense some air pollutants

Nuha Salim jasim AL-moula[1], Ahmed Noori Mahmood[2]
[1, 2]College of Environmental Sciences and Technologies/ University of Mosul/Iraq
Email: nuhasalim414@gmail.com
Email: ahmednoori@uomosul.edu.iq

Summary

In this research, a group of materials that consist of the base material, which in this research is a substance (resin substance), while the substance (Master Brace ADH 1406 Part B) is a substance (hardener) in a natural ratio (3 R: 1 H), these sensors are substrate fortified with CuSO4 and by weight (20%-30%-40%) these have undergone phases during the contract term. Five types of seven cubes of the first type of the complete type and a complete arc of the first type of snowballs, and the resistance to compression, and that after the result of the reinforcement, as the results did, there are a number of elements that were identified among them, among them, which is a percentage (30%). It makes it appear as a single spectrum. This result indicates an interaction between the surrounding materials and the medium, and the results show a picture of the possibility of the beginning of decomposition in the material, or there are elements resulting from the outer ring. And seven of the surface oceanography.
Keywords: $CuSO_4$ powder; air pollutants; epoxy-based composite

1. Introduction

The process of monitoring the variables of the air content of the components, which are supposed to be within the natural rates, is one of the very important matters, which has taken a large part of the researchers' interest in monitoring this variable. The reason is that any defect in the components of the air is in fact a defect in the ecosystem in general. (Paoli & Loppi, 2008). The process of observing these changes in the nature and quality of the components of the atmosphere has become at the present time a necessary process that cannot be overlooked as a group of reasons, and among these reasons, the large and unexpected escalation of the causes of imbalance and imbalance in the components of the atmosphere. The process of spreading pollutants is now a process that is close to getting out of control, and we are working within the limits of danger, so the process of monitoring variables has become inevitable. (Jiang.et al, 2015). Systems must be able to operate efficiently within the requirements of the work and therefore, since air pollution is a currency in many ways, we have to choose multiple systems. These systems must be taken into account in their organization to be able to deal with cases higher than the existing ones due to the abnormal acceleration. Between them so that we can build an information base that makes us able to predict what will be and at the same time evaluate what is and find successful solutions. Accordingly, techniques began to appear in order to achieve this goal, in addition to employing several other techniques in this research. A substance we called a sensor to try to observe the composition of some substances within a specific area of study and to make this observation a visual observation (color change). (Almeida et al, 2012).

2. Method of work

This framework includes three main axes, the first axis is a review of the materials that were used in the manufacture of the models (epoxy), as well as the chemicals added to the models as well as the materials of the virtual medium. This process is the method of manufacturing the casting molds, the casting methods, and the surface treatments that took place after the models were dried. Finally, the third axis included a description of the tests that the models underwent, including mechanical tests, as well as X-ray tests (synthetic tests) and scanning microscope tests (spectroscopic tests).

3. Materials used

1- The base material that is in this research is the epoxy material manufactured by (BASF), which includes (Master Brace ADH 1406 Part A) which represents (Resin) while the material (Master Brace ADH 1406 Part B) is Hardener, in the standard mixing ratio of the substance [3 R : 1 H] .
2- CuSO4 copper sulfate.
3- The default medium materials (ammonium sulfate NH4)2SO4)-cadmium sulfate CdSO4).

Mold making

Molds were manufactured from aluminum plates with a thickness of (mm1) for the manufacture of casting molds used in making models, with dimensions of 1 * 1.5 * 18 (cm).

Mixing and pouring method

I used epoxy, which consists of two materials, Resion

doi.org/10.31838/hiv23.01.40 Received: 25.09.22, Revised: 15.10.22, Accepted: 16.12.22

with Hardener, where 9 cm3) of Resion is placed in a test dish, and then (3cm3) of Hardener is placed in stages, where it is placed and the mixture is mixed well. After this process, the mixture is poured into the mold prepared in advance, then the model is left without movement for a whole day at the casting site, then the model is transferred to plastic containers with ventilation holes for 7 days under environmental laboratory conditions, then we open the sides of the model, the model is left for two days after Opening its sides in the same container, then the model is lifted from the mold by using the ends of the tape, then the model is left for a month in these cases to ensure that it reaches the stage of complete solidification. After this process, the adhesive tape is removed from the body of the model, then the model is washed with distilled water, dried directly with filter papers, and left for two hours to ensure drying, after which it is subjected to examination using a normal light microscope with a magnification power of 400X to ensure that the model is free of defects. After this stage, the stage of surface treatments is completed. whose main objective is to modify the dimensions of the model within the specified measurements. This process is carried out using sheets of silicon carbide material with a granular size of (400,1000,2000 #) (mesh, which is the number of holes in one square inch and its symbol #) after this stage the model is re-washed A second time, dried, and then we adjust the dimensions of the model in two ways, the first using the Varney), which can determine the thickness or the uniformity of the thickness in total and in different locations. The second method, through which we can determine the regularity of the surface of the model through the use of light microscopy.

Manufacture of samples of the base material to which the reinforcing material is added

The models in which the reinforcing materials are added were manufactured, as they depended on the same mechanism that was adopted in the manufacture of the base material and with the same stages and timings, where the weight ratios were added 20%-30%-40% of the total model weight. 9cm3 of Resion is added in A dish that is cleaned, as in the case of manufacturing molds of the non-added base material, after which the Resion material is mixed, and then the reinforcing material is added in the form of batches after completing the addition process. Base material templates.

Mechanical checks

Surface hardness check

The surface hardness of the models that were manufactured was checked by using a shockproof device to measure the surface hardness. The Japanese-origin Shore (N.S.S) type device was used. This device measures the surface hardness by creating a shock on the surface of the model. Through this shock, the device can determine the surface hardness value and show the amount of this value on the scale that is located at the top of the device, as this scale contains an indicator that directly determines the hardness values.

In order to obtain high accuracy in hardness measurement, the following must be taken into account.

1. The device is set at the correct level so that the shock device forms a perpendicular position on the surface of the model, this condition can be achieved by balancing the device using the calibration screws located at the bottom of the device and the plumb installed in the front of the device.
2. Taking into account the uniformity of the surface of the model whose surface hardness is to be determined.
3. At least three measurements are made at close locations on the surface of the model and the average readings are taken.
4. Examination of standard models attached to the device and the hardness information supplied by the device manufacturer.
5. The surface hardness value of the model represents the average of the hardness values, which were taken to locations on the surface of the model, where the hardness values of several different areas are taken from the surface of each model, and they were measured by the Shore (SH) system.

Compressive Strength Check

The relative weakness in the mechanical properties of polymeric materials in general, as well as their ability to resist compression in particular, used the Spesac Graseb manual hydraulic press. This type of press is used to prepare and press a wide range of cylindrical samples, as it is used at a maximum compressive strength of (15 Tons). After making a simple modification on the capping surface of the model.

The following mechanism was adopted to conduct compressive strength tests for the manufactured models. The dimensions of the sample used in the examination are (30 x 30 x 5 mm) and these dimensions were obtained by the same mechanism mentioned in the previous paragraph. An initial pressure (which is relatively little) is applied to the model for a period of time (5 min).

When the model bears this pressure and does not break it, the pressure is increased gradually and for the same approved period of time. At each stage in which the pressure is increased, the model is replaced to ensure that the remaining stresses in the model do not affect the result of the initial examination.

Replaced models are of one origin, meaning that one model is divided into several models. The amount of pressure at which the model broke, which represents the maximum value of the compressive strength, is recorded, as it can be calculated from the relationship (2).

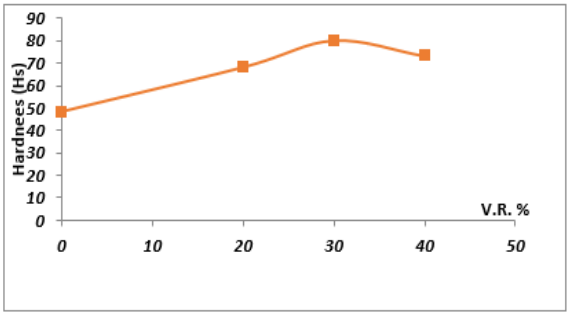
Compressive strength=pursue/Area=(W*g)/(Length*Width)=N/(mm^2) (2) whereas:
w: the equivalent mass of the pressure applied to the model g: ground acceleration.
Length & width: the dimensions of the model.

3- X-ray tests: It is an analytical method used to analyze the properties of materials. The samples were examined by Podwe XRD, 2700AB, HAOYUANCO, China.

4- Scanner tests: the samples were examined by the device FESEM (Zeiss Sigma 300-HV) GERMANY

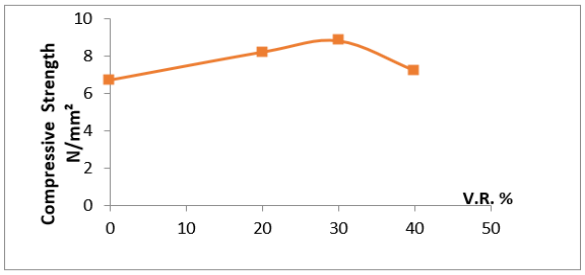
4. Results and discussion

Mechanical Tests: Hardness is defined as the ability of a material to have an effect on its surface. Therefore, surface structure and cohesion are among the main factors in increasing or decreasing the value of surface hardness resistance.
It is noticed from the figure that the amount of hardness of the base material increases when adding the reinforcement material ($CuSO_4$ sulfate) to reach the highest value at 30% and then decrease again (TOH et al, 2018), and in order to interpret these results we have to understand that the surface uniformity value depends on Directly on the value of the uniformity of the inner layers of the material, where the higher the inner layers of the material, the uniformity of the surface will increase, which will lead to an increase in the value of the surface resistance, so the presence of the reinforcement between the polymeric chains will lead to an increase in the agglutination of the polymeric chains, which will lead This leads to an increase in surface cohesion and leads to an increase in surface resistance or surface hardness (Abdalla.et al, 2019)).



The figure represents the hardness of the fabricated samples reinforced with $CuSO_4$

Compressive resistance tests: We note from the figure the value of the compressive strength of the base material increases with the addition of the reinforcement material to reach the highest value at the percentage of 30% to then return to decrease. The base material, which in turn will lead to filling the interspaces in the composition of the base material, which in turn will lead to an increase in the material's ability to resist compression by keeping the polymeric chains in their positions with the application of external stress and that the best compressive strength has been obtained at the value 30% may mean that this The value may have provided the best homogeneity in the distribution of the reinforcement material with the base material, and thus the best chance of compressive strength could be provided on each area of the model hull. (Wang.et al,2020).

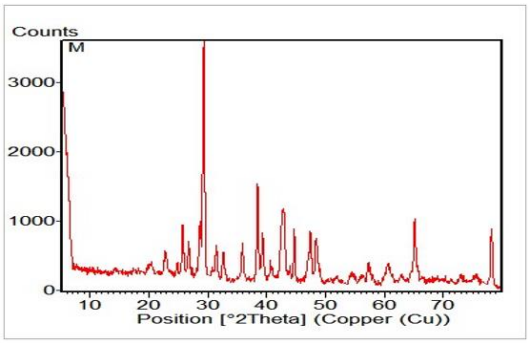


The figure represents the compressive strength of the fabricated models reinforced with $CuSO_4$

X-ray examinations

X-ray analysis of the base material

The figure can illustrate the most important observations obtained by analysis, namely that a random spectrum with the presence of some peaks at positions 30-49-43-65 and that there are secondary peaks with intensities ranging between 1500-500 are weak converging peaks that give the impression that they are closer to Continuous (random) spectrum for linear spectrum. Also, the end of the peaks is a precise end, which means that it is a highly crystallized substance and that it emerges within a random structure with high intensities and in a highly crystallized form, a condition that gives it the status of sovereignty (dominant trait) (Phadnis.et al, 2013). In general, the results show that they are the results of a continuous random spectrum of the overlap of the peaks with the presence of distinct peaks, and that the communication between the peaks is very close, and that matter contains two properties, the property of randomness in general and crystallized matter in particular. It contains compounds with high heterogeneity with random compounds. (Czabag. et al, 2014).



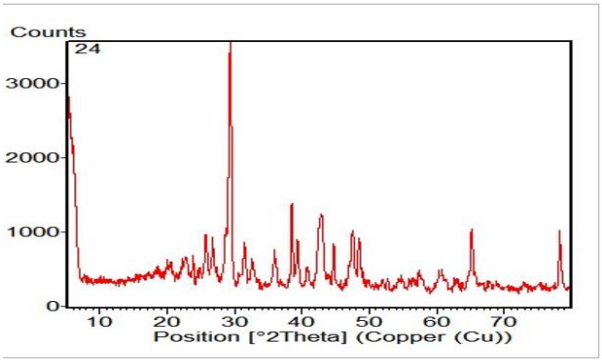
The figure represents the X-ray spectrum of the substrate

Analysis of X-ray examinations of the sample, the base material, with 30% of copper sulfate added.

We note from the X-ray diffraction spectrum of the substrate supported by 30% of copper sulfate CuSO4 that the spectrum is almost approximate to

the spectrum of the substrate with some distortion in the background of the spectrum, especially at small deviation angles. It has remained preserved in its composition with some change in the value of the concentration of its components, and the background of the diffraction spectrum has increased relatively, which gives a picture of the possibility of the beginning of decomposition in the material or there are elements that have been added through the external environment that led to its entry into the composition of the material in general, which made it It tends to have continuity (randomness), a condition that is likely to have occurred due to the virtual environment (Ermrich Opper & 2013).

The height of the peaks of the base material has changed relatively at some sites, which means that there is either a process of blocking some elements by the action of the ocean and the addition substance, or an interaction occurs, which is most likely between the ocean substance and this substance, which can be considered the beginning of a disintegration and re-linking of the elements of the base material (Friedbacher ,2011).



The figure represents the X-ray spectrum of the spectrum of the base material, in which 30% of copper sulfate $CuSO_4$. is added

Scanning Electron Microscope (SEM) Assay Analysis

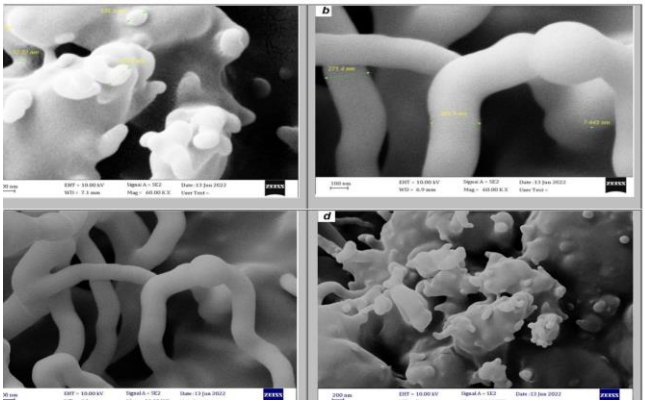
Figure (a) is a picture of a section of the surface of the unsupported substrate, where it is noted that an irregular polymeric structure is interspersed with some voids, and that the characteristic quantitative diameters of this structure range from (38 nm) to (185.6 nm) with the presence of some cavities between the structures basic infrastructure,

This structure is generally an irregular structure and it is likely that the circumstance of solidification and the nature of the injection have a very large influence on such a formulation. This picture was taken when after scanning (100nm).

Figure (b) is a picture of a section of the surface of the base material showing its linear structure of the polymeric chains, where it is noted that there is a bundle structure of polymeric chains with diameters ranging between (271.4nm-301nm) these diameters represent the bundle of polymeric chains that constitute the regular body of the base material, et al González, 2006).

Figure (c) is a section of a survey site with a dimension of (200 nm) showing a more comprehensive picture of the bundle of polymeric chains.

Figure (d) It is noted that there are clusters in which the linear shape disappears, this case (the linear shape with the aggregative shape directly depends on the conditions of solidification and injection).



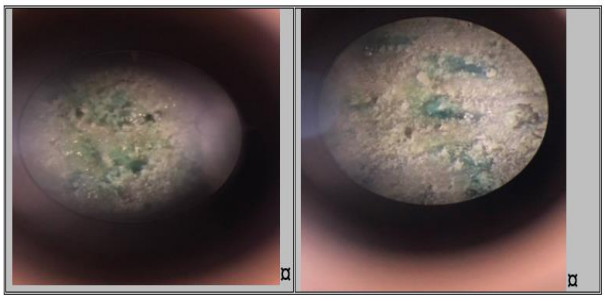
Scanning electron microscopy assay analysis of the substrate supported by 30% $CuSO_4$. copper sulfate powder

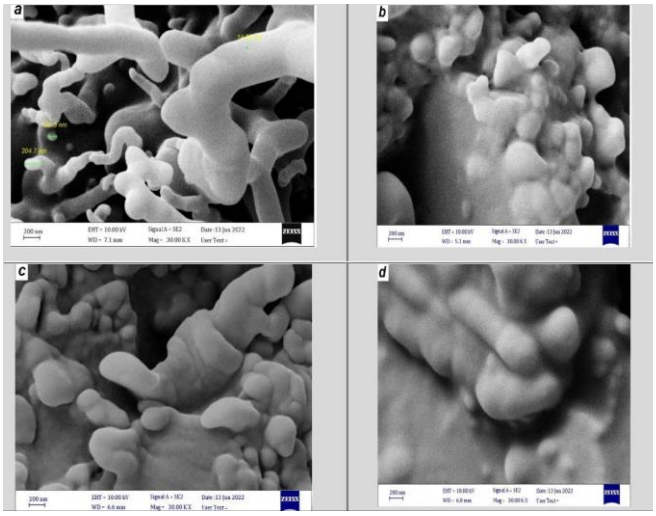
Figure (a) The figure shows an image with a magnification of 200 nm. The presence of structures or particles with diameters (100.5 nm-204.7 nm) These compounds may be the default medium materials.

Figure (b) a section of a survey site with a magnification of 200mn)), as we note the presence of some cavities between the basic structures, and these structures are random and irregular, as well as the presence of spaces that permeate the basic structure is likely to be due to the condition of sclerosis and the nature of the injection has an effect such as this case .

Figure (c) The figure represents an image of scanning the surface of the model supported by 30% of copper sulfate CuSO4 with a magnification of 200 nm), as we note the presence of nodal structures and cumulative structures also with the presence of cavities or voids permeating the structural structure (2017, Zhao & Zhang)

Figure (d) The figure represents a scan image with a magnification force of 200 nm for the base material reinforced with copper sulfate by 40%, as we notice from the figure that there are more regular areas than what was on the base material alone (unreinforced) and may be due to the nature of the solidification, as well as the presence of other materials The reinforcement that gives a kind of thermal uniformity during the solidification process.





Analysis of the results of light microscopy

It is observed from the following figures a microscopic image of some samples of the manufactured and reinforced base material chemical ($CuSO_4$ sulfate) and by weight percentages (20%-30%-40%), and the treatment with the hypothetical medium consisting of (ammonium sulfate SO_4 $2(NH_4)$-cadmium sulfate $CdSO_4$) for a period 48 days, as these figures represent pictures of a microscopic examination with a magnification of 400X)) and it is noted that there are areas of distinct color from the rest of the body of the model, this color occurred due to the interactions that took place between the material of the virtual medium and the reinforcement material with the possibility of an interaction between the epoxy material and the medium The presence of a mediator may be a reinforcing material.

5. Conclusions

After analyzing and interpreting the results in this research, the following conclusions were reached:

1. The mechanical properties of the base material used in this research (epoxy) improve when reinforced with additives (reinforcement materials).
2. The presence of the reinforcing material leads to filling the interspaces between the polymeric chains, which leads to an increase in the bonding of the chains with each other.
3. The added chemical improved the mechanical properties in varying proportions.
4. The best percentage of improvement in mechanical properties was at 30%, which was the optimum percentage for the amount of reinforcing material.
5. The physical adsorption and chemical adsorption probably resulted from the interaction of the medium with the substrate.

References

Abdalla, L. B, Ghafor, K, & Mohammed, A. (2019). Testing and modeling the young age compressive strength for high workability concrete modified with PCE polymers. Results in Materials, 1, 100004.

Almeida, S. M, Lage, J, Freitas, M. D. C, Pedro, A. I, Ribeiro, T, Silva, A. V, ... & Wolterbeek, H. T. (2012). Integration of biomonitoring and instrumental techniques to assess the air quality in an industrial area located in the coastal of central Asturias, Spain. Journal of Toxicology and Environmental Health, Part A, 75(22-23), 1392-1403.

Czabaj, M. W, Riccio, M. L, & Whitacre, W. W. (2014). Numerical reconstruction of graphite/epoxy composite microstructure based on sub-micron resolution X-ray computed tomography. Composites Science and Technology, 105, 174-182.

Ermrich, M, & Opper, D. (2013). XRD for the analyst. Getting acquainted with the principles. Second. Panalytical.

Friedbacher, G, & Bubert, H. (Eds.). (2011). Surface and thin film analysis: a compendium of principles, instrumentation, and applications. John Wiley & Sons.

González, G. P, Hernando, P. F, & Alegría, J. D. (2006). A morphological study of molecularly imprinted polymers using the scanning electron microscope. Analytica chimica acta, 557(1-2), 179-183.

Jiang, W, Wang, Y, Tsou, M. H, & Fu, X. (2015). Using social media to detect outdoor air pollution and monitor air quality index (AQI): a geo-targeted spatiotemporal analysis framework with Sina Weibo (Chinese Twitter). PloS one, 10(10), e0141185.

Paoli, L, & Loppi, S. (2008). A biological method to monitor early effects of the air pollution caused by the industrial exploitation of geothermal energy. Environmental Pollution, 155(2), 383-388.

Toh, W, Tan, L. B, Tse, K. M, Giam, A, Raju, K, Lee, H. P, & Tan, V. B. C. (2018). Material characterization of filament-wound composite pipes. Composite Structures, 206, 474-483.

Phadnis, V. A, Makhdum, F, Roy, A, & Silberschmidt, V. V. (2013). Drilling in carbon/epoxy composites: Experimental investigations and finite element implementation. Composites Part A: Applied Science and Manufacturing, 47, 41-51.

Wang, B.; Fang, G.; Tan, X.; Liang, J.; Ge, J.; & Liu, S, (2020). " Investigation On The Longitudinal Compressive Strength Of unidirectional Carbon Fiber / Nanoparticle Reinforced Polymer Composites Using FFT- Based Method ", Journal Composite Structures, 112448.

Zhao, J, & Zhang, D. (2017). Epoxy-based adhesives filled with flakes ag-coated copper as conductive fillers. Polymer Composites, 38(5), 846-851.