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Morphological Analysis of Unstructured and Prestructured Magneto-rheological Elastomer

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Abstract: By providing or not put on a magnetic flux, a magneto rheological (MR) elastomer becomes a very powerful and advanced smart material that could be twisted and responded hurriedly in relations of mechanical strength. They are elastomer materials with embedded iron elements in an elastomer environment. Isotropic(unstructured) and anisotropic(prestructured) MR elastomers are categorized built on the submission of a magnetic flux during in the fabrication process. The scattering of magnetizable elements in the medium of an elastomer is well defined and arranged by kind. Scanning Electron Microscopy(SEM) had revealed their shape. They should be employed in a variability of solicitations payable to their improved morphological characteristics, such as pulsation absorbers, isolators, seismic devices, and so on.
Keywords: Smart material, magneto rheological elastomer, carbonyl iron particles, morphology, scanning electron microscopy

I. INTRODUCTION

In recent years, innovative smart and bright functional provisions have received considerable attention, as the growing trend of superior and relaxed regime has led to an increase demand for both new technologies and materials. Smart resources are those that are well enough to environmental factors including electrical or magnetic fields, mechanical stress, heat, and light. In standings of their vast industrial potential, magneto rheological (MR) resources have arisen as the biggest smart resource. They are categorized as practical smart material resources featuring rheological and viscoelastic capabilities such as yield and shear stress, as fine as damping properties when subjected to an external magnetic field [1, 2] MREs, on the new hand, may be classified into two different groups: isotropic/unstructured and anisotropic/prestructured MREs, based on the MREs' attractively polarised particle structure. The polarized elements are uniformly dispersed in an isotropic MRE, leads to physical performances that are comparable in all dimensions. The magnetic particles in an anisotropic MRE are ranged in same direction as the input magnetic field. These materials were selected for this research due to various their intrinsic properties under external magnetic flux and subsequent applicability in vibration absorbing devices [3, 11].

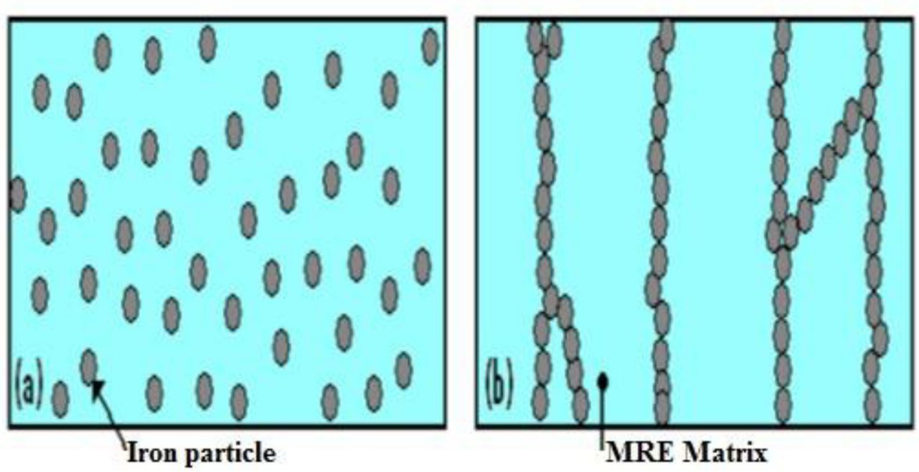

Figure 1: Isotropic/Unstructured and anisotropic/Prestructured MRE's

In this investigation, isotropic/unstructured and anisotropic/prestructured MREs were made utilizing 15 and 30 percent iron elements by weight of the elastomer atmosphere accordingly, and SEM analysis has been used to assess the internal morphology structure of the unstructured and prestructured materials [5, 6].

II. FABRICATION OF ISOTROPIC (UNSTRUCTURED) AND ANISOTROPIC (PRESTRUCTURED) MAGNETO RHEOLOGICAL ELASTOMER

An anisotropic magnetic elastomer (MRE) is an useful and informative pre-structured magnetic elastomer. This outside magnetic flux is applied to the mixture of elastomer medium and magnetic particles during in the curing/drying process. The isotropic MR elastomeric material is among the most beneficial unstructured magnetic elastomers available. There was no exterior magnetic flux applied to the mixture during the curing/drying process. MRE is an elastomer medium which comprises ferro-magnetic elements and is cured in the insertion or exclusion of magnetics flux, dependent on such kind. The elastomer exploited for MRE is PDMS that occurs in two forms: type A (liquid reagent) and type B (curing reagent). Iron elements were used at 15% and 30% by weight of the elastomeric medium mixed in Si oil accordingly. The PDMS elastomer was selected because of its easy curing procedure and wide temperature range of application. During the drying process of prestructured MREs, a magnetic flux were applied employing permanent magnets. Both samples were provided a 48-hour cure time [1, 4, 8]. There are four samples in total, in which dual are isotropic while the other two are anisotropic. 15gm of CIP has been used to create MRE 1 and MRE 2. The existence or absence of magnetic flux is resolute by the sort of magnetic flux, MRE 1 was unstructured, while MRE 2 was prestructured nature [12].

Table I: Content by Weight Castoff for MRE (1 AND 2)

Sample Type	Part A	Part B	Si Oil	CIP	Curing Time
Unstructured & Prestructured MRE	100	10	15	15	48

(Both samples are of identical contents, Sample 1 and 2)

Samples 3 and 4 were made with 30g of CIP. The occurrence or absence of magnetic flux is determined by the type of magnetic flux. MRE 3 was prestructured MRE, whereas MRE 4 was unstructured MRE.

Table II: Content by Weight Castoff For MRE (3 AND 4)

Sample Type	Part A	Part B	Si Oil	CIP	Curing Time
Unstructured & Prestructured MRE	100	10	25	30	48

(Both samples are of identical contents, Sample 3 and 4)

Figure 2 represents the real image of unstructured MRE and prestructured MRE with 15g of CIP.

Figure 2: Isotropic/Unstructured (MRE-1) and Anisotropic/Prestructured (MRE-2)

Figure 3 represents the real image of unstructured MRE and prestructured MRE with 30g of CIP.

Figure 3: Isotropic/Unstructured (MRE-3) and Anisotropic/Prestructured (MRE-4)

III. MORPHOLOGICAL BELONGINGS OF MAGNETO RHEOLOGICAL ELASTOMER

The deflection of magnetic elements and the grip between both the carboxyl iron elements and the medium are critical to the MRE's capabilities. Scanning electrons microscopy (SEM) is castoff to analyze the morphology of unstructured and prestructured MREs. We used JSM-IT 200 SEM machine from Bombay Textile Research Association, Mumbai which is semi-government research organization. The model is soaking in LN2 and censored perpendicularly to detect the MRE structure. The matrix plus distribution condition of magnetic elements can be observed by this morphological reflection [7, 9, 10]

Technique for formulating samples for SEM Analysis in detail.

A. Cutting of the Model

Cut the specimen upright to the region where the image will be seen.

B. Sample Cleaning Preparation

Cleans the sample with a proper buffer and a proper buffing procedure. Phosphate buffers are usually used to clean the specimen of the any inorganic or dust reagents that could be present on the apparent.

C. Drying

Dry the specimen for a period using the simple air dry technique.

D. Immersion in LN2

To get a clear view of an object, the sample was dipped and immersed in liquid nitrogen (LN2) for a minute to freeze the object and surface. Due to the temperature sensitive features of liquid nitrogen (LN2), the specimen is dropped and soaked in the same thermocol box.

E. Coating with Gold

To concentrate the specimen conductive or increase the conductivity of the specimen, and to also prevent the specimen from being activated by sampling and to limit the damage of the electron sunbeam during testing, it is coated with such a conductive material, most frequently common gold coating. The metallic material is practical in a skilled manner in a samples were coated once an appropriate vacuum environment is maintained. The detail that the coating is dense enough to prevent charging but not dense enough to cover specimen surface details is a severe problem. Reliant on the objects, the process takes 8 to 12 min to complete. Figure 4 depicts a gold sputter coating machine.

Figure 4: Gold Sputter coating machine

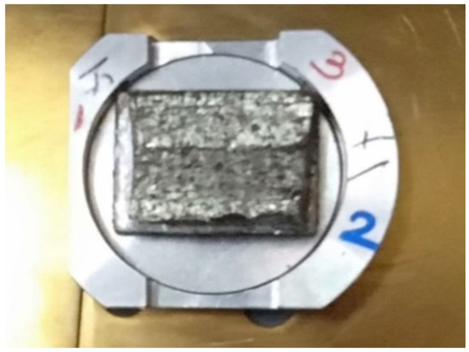

Figure 5: Prepared Sample for SEM (Gold Coated)

F. Observation

The specimen well with gold layer coating applied is now ready for testing to determine its morphological structure. Figure 5 shows the prepared sample with gold coating after LN2 absorption for SEM observation.

Figure 6a shows a SEM appearance of an unstructured MRE with 15gm of CIP fabricated in the nonappearance of a magnetic flux, and Figure 6b shows a SEM appearance of a prestructured MRE with 15gm of CIP fabricated in the exterior magnetic field during drying. The magnetizable elements in the medium were spread randomly all through the figure. SEM pictures of a prestructured MRE sample are shown in Figure 6b. The carboxyl iron elements are ranged in the elastomeric media in Figure 6a SEM image, revealing that it is prestructured MREs. These morphological characteristics are inherently connected to the mechanical plus magnetic belongings of MREs, and they are essential for solicitations.

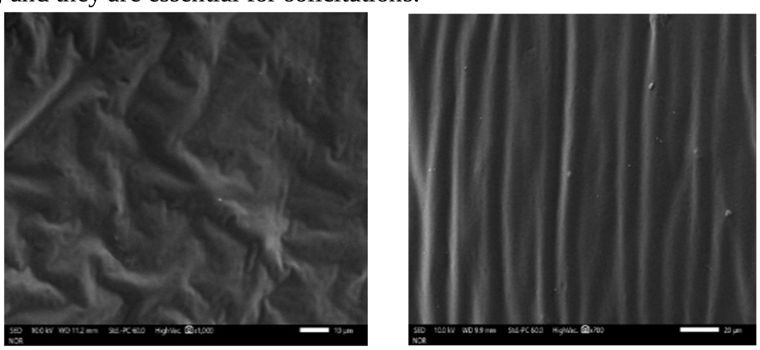

Figure 6: SEM images of Isotropic/unstructured/MRE-1 (a) and Anisotropic/prestructured MRE-2 (b) [JSM-IT 200, BTRA Lab, Mumbai]

Figure 7a shows a SEM image of an unstructured MRE produced in the absence of a magnetic flux with 30g of CIP, whereas Figure 7b shows a SEM image of a prestructured MRE fabricated in the external magnetic field during curing.

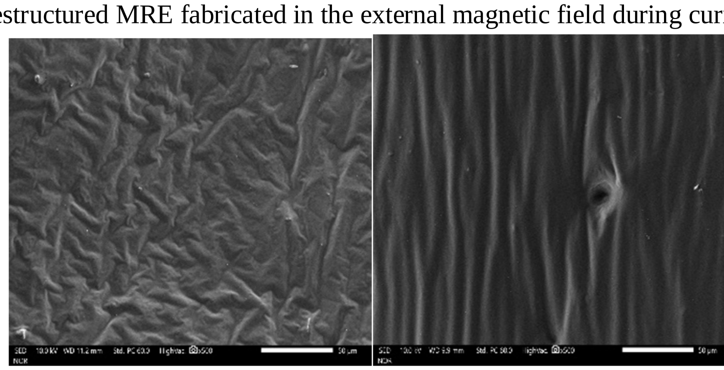

Figure 7: SEM images of Isotropic/unstructured/MRE-3 (a) and Anisotropic/prestructured/MRE-4 (b) [JSM-IT 200, BTRA Lab, Mumbai]

The variability in volume concentrations of CIP in the matrix of elastomer is clearly apparent in figures 6 and 7. Although the variability of CIP volume concentration was revealed, both figures completely satisfied the principle of MRE kinds and their nature in relationship to magnetic flux applied.

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IV. DEFECT REVEAL IN MRE SAMPLE

SEM analysis revealed significant defects in anisotropic (prestructured) MRE comprising 30g by weight iron particles. A blow hole may be seen from the morphological image of the present MRE specimen. The lack of a proper surrounding environment as a result of MRE preparation was the main reason. To eliminate the drawbacks of blow holes in MRE, the MRE must be processed in a vacuum environment as a result of blending the MRE mixture. The SEM picture of anisotropic (prestructured). MRE fabricated in the applied magnetic field during curing is shown in Figure 8.

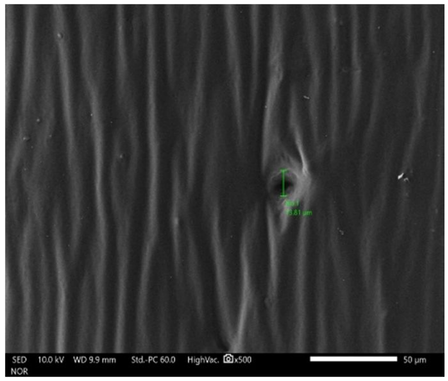

Figure 8: SEM images of anisotropic/prestructured MRE with blow hole (size 13.81µm) [JSM-IT 200, BTRA Lab, Mumbai]

The carbonyl iron particles are aligned in the elastomeric medium in SEM images of prestructured MRE, suggesting that it is anisotropic/ prestructured MRE. These morphological properties are inherently connected to the mechanical and magnetic and optical properties of MREs, and they are essential for applications.

Blowholes were seen in anisotropic / prestructured MRE as a upshot of the lack of proper vacuum surrounding during in the blending of the MRE mixture. SEM was castoff to assess the dimensions of the blow hole, which approximated 13.81m. Although the numeric value of the current blowhole is small, the attendance of such blowholes has an influence on the mechanical properties of MRE. Because these kinds of morphological observations are so tightly connected to the mechanical and MR properties of MREs, they're essential for applications. To avoid the presence of blow holes in MRE and the drawbacks of blow holes in MRE, the MRE must be produced in a vacuum condition during the blending of the MRE mixture. The example of a prestructured MRE was used here, but it will occur in any form of MRE if a sufficient vacuum environment is not provided during the blending of the MRE mixture.

V. CONCLUSION

We looked into the fabrication, categories, belongings, and uses of smart MREs in this study. SEM images have been used to detect the structure of unstructured and prestructured MREs, as well as their mixing and physical appearances. The medium and dispersion state of iron particles can be seen towards the end of this morphological reflection. SEM images of an unstructured MRE produced without the need for a magnetic flux revealed a matrix of randomly dispersed carbonyl particles. During curing, SEM images of prestructured MRE synthesized in magnetic flux revealed that the magnetizable particles are brought into line in the elastomeric medium, relieving the anisotropic character of the MREs. The variance of volume concentration of CI elements in the elastomer medium is clearly seen by glancing at the morphological structure of all MREs. Although the variety of CI elements volume concentration was demonstrated, both figures completely satisfied the principle of MRE kinds and their nature in relative to magnetic flux applied. These morphological features are inextricably linked to the mechanical plus magnetic possessions of MREs, and they are essential for applications.

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