Effect of carbon black and graphene on the performance of EPDM rubber composites: A short review

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Abstract. Ethylene Propylene Diene Monomer (EPDM) rubber is for major used in engineering and many technical works and its application like automobile, constructions, electronic industries, and electric and many more. Industries commonly EPDM use for making the rubber inlet/outlet hoses for car and other vehicle. EPDM rubber properties are like good weather resistance ability as well as heat ozone. The resistance of steam is outstanding. EPDM rubber commonly is used for seals in automobile area. In the present review paper, different hardness of EPDM has been discussed on the basis of mixing or adding different proportion of graphene and carbon black (CB) and other additives. Also discussed how improve the performance of EPDM using silica and graphene and titanium dioxide and other additives and synergistic effect of graphite nanotubes on EPDM nanotubes. Effect of graphene on non-polar and polar rubber matrix also discussed with mechanical behaviour of EPDM.

Keyword: EPDM; graphene; nanocomposites; mechanical properties.

1. Introduction

Rubber is very widely used as adhesive in many products and industrial services & application and other use of rubber products like Hoses for automotive industries for air passing inlet or outlet hose and rubber also use for making belts, matting, flooring, medical gloves and much more [1]. Rubber product is widely used in automotive industry, examples; bumper, hose, mats, tires and O-ring. There are largest consumers of rubber like tires and tubes. On the other hand, rubber is used for household item includes boots, raincoats, cushions, pillows, hot water bottles etc [1].

The rubber materials use in engineering field, not new because it’s application importance is much at that time in these related field. When nanofiller materials such as carbon black and nanotubes and nano fibers as well as organophilic clay and many other contents are added to the rubber, the improved properties can be achieved [2, 3]. In other words rubber compounds with additives like carbon black surface and accelerators. This type of dough mixture is known as compound and it converted into milled sheets with desired thickness.

Rubber component fails due to different factors like wear and friction. Rubber friction is categorized as Adhesion and hysteresis type. On the other hand, primary agents impacted on rubber materials and
deteriorate much humidity, high temperature, pollutant gases, oxygen & stress and other forces. The main impact of wear is categorized. Wear is defined as a material elimination from the solid surface. In other words wear is erosion of material by the action of another solid. Wear are of two types; adhesive (15%) and abrasive (50%) found in EPDM [1]. In abrasive wear elimination of material done through to the penetration of hard particles. Further, abrasive wear can be divided into two types, First, abrasive wear between two bodies where fixed particles or rough surface slide over another surface to remove the material. Wear in rubber is more important because rubber parts are extensively used in different types of structural application. The abrasion wear resistance can be controlled and enhanced some other supporter occur due to well-ordered experimental condition in laboratory. Wear is created in real-life application / uses like tires on road. According to Schallamacn, the nature of failure of rubber part is very similar to mechanical fracture. The waves appear in the surface of rubber due to tension in the forward during the loading cycle of ultimately buckling and compression in the back portion of the rubber [1]. Schallanach was firstly observed this phenomenon and is known as Schallanach waves. In this present paper, improvement of EPDM rubber composite possible using graphene, silica, titanium dioxide, and other additives have been discussed. Furthermore, synergistic effect of graphite nanotubes and CB also discussed on multifunctional EPDM nanocomposites.

2. Effects of carbon black (CB) and graphene on sliding wear and dry friction on EPDM rubber

When increase the proportion of CB filler wear have been reduced. The dry friction and sliding wear of EPDM were discussed against steel included CB content using different processes. The specific wear rate and coefficient of friction (COF) of EPDM were discussed with the help of EPDM rubber characterized using tensile compression test and dynamic-mechanical thermal analysis [2]. Increasing carbon black content result reduced specific. Silica titanium dioxide and graphene additives are used to improve the performance of EPDM rubber. Composite was fabricated by ethylene propylene diene monomers comprises additives of modified fumed silica (MFS) with graphene and titanium dioxide (TiO₂) as mentioned in Table 1. Incorporation of additives raised the thermal conductivity and thermal stability (30-50 °C) of composites. The combination of aforementioned improvement gives better performance to polymer composite for insulating application [3].

Table 1. The formula of the prepared composites [3]

| Component               | EPDM (phr) | S (phr) | TiO₂ (phr) | MFS (phr) | G (phr) | DCP (phr) |
|-------------------------|------------|---------|------------|-----------|---------|-----------|
| EPDM                    | 100        | -       | -          | -         | -       | 0.7       |
| Silica                  | -          | 100     | -          | -         | -       | 0.7       |
| EPDM/TiO₂_20/G2         | 100        | 20      | 2          | 0.7       |
| EPDM/MFS_10/G2          | 100        | 10      | 2          | 0.7       |
| EPDM/MFS_10             | 100        | 10      | 0.7       |
| EPDM/S/TiO₂_20          | 50         | 50      | 20         | 0.7       |
| EPDM/TiO₂_20            | 100        | 20      | 0.7       |
| EPDM/S/TiO₂_20/G2      | 50         | 50      | 20         | 2        | 0.7     |
3. Synergistic effect of grapheme nano-plates and carbon black in functional EPDM nanocomposite

EPDM based nanocomposite containing graphite nanoplates (GNPs) and carbon black and mixture of the two filler were prepared, the effect of two filler on the static and dynamic friction found. The sample comprising of effective amount of (GNPs) and (EPDM/CB) composite provides an inner ease at the mechanical properties and thermal conductivity damping and mechanical properties of nanocomposites [5].

4. Mechanical property of CB & EPDM

EPDM rubber filled with rubber this is mainly used in thermal combustion engine mechanism where rubber hose of a cooling radiator carbon nanotubes (CNTs) were added to EPDM rubber filled with 75 phr CB to from CNT reinforced CB-filled EPDM rubber. Figure 1 shows the dynamic coefficient of friction variations at different content of GNPs/CB. Figure 2 shows the modulus at different strain rate and strength of samples.

![Figure 1. Static and Dynamic COF measured for the prepared samples [6].](image-url)
Figure 2. Modulus at different strain rate (black 50%, red 100% and blue 300%) for the different samples [6]. (b) Maximum strength.

5. Effect of graphene on polar and non-polar rubber matrices.

In this study or process when graphene oxide (GO) and reduced graphene oxide (GO) on the physical properties of polar acrylonitrile–butadiene rubber (NBR) and non-polar (EPDM) matrix have been investigated and compression between the properties of NBR and EPDM. NBR Vulcanizates found higher cure rates compare to EPDM rubber system. After experiment its observed various properties like tensile, and dynamic mechanical analysis, cross linking density evaluated. In this study it’s also indicate the future scope in industry of rubber-graphene nanocomposites for several applications includes the structural barrier the die electric energy storage materials.

6. Conclusions

- In present paper the sliding and dry friction wear of EPDM rubber against steel as function of carbon black has been discussed.
- Improvement of EPDM rubber composite possible using graphene, silica, titanium dioxide, and other additives.
- Synergistic effect of graphite nanotubes and CB also discussed on multifunctional EPDM nanocomposites.
- Mechanical behavior of EPDM and CB has also been discussed.
- Outcome of graphene on polar and non-polar rubber matrices also discussed.

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