



Cairo University

# PHYSICO-MECHANICAL PROPERTIES OF NBR/EPDM RUBBER BLEND LOADED WITH DIFFERENT TYPES OF COMPATIBILIZERS

By

Reem Mohamed Salah Mahmoud

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
In Partial Fulfillment of the  
Requirements for the Degree of  
MASTER OF SCIENCE  
In  
Chemical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
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**Title of Thesis:**

Physico-Mechanical properties of NBR/EPDM rubber blend loaded with different types of compatibilizers.

**Key Words:**

NBR; EPDM; Rubber blends; Compatibilizers; NBR/EPDM characterization.

**Summary:**

The purpose of the present research is to compare between the effect of different types of compatibilizers (Maleic anhydride, epoxidized soybean oil and styrene butyl acrylate S-BA copolymer), which was added to overcome the incompatibility between NBR/EPDM blend, on the rheological, mechanical, physical and thermal properties of NBR/EPDM blends as well as to obtain the optimum amount of each type of them which will give such a superior properties. Blends of EPDM and NBR were prepared with different ratio (100/0, 75/25, 50/50, 25/75 and 0/100 EPDM/NBR) and the effect of the blend ratio on the mechanical, rheological and thermal properties have been investigated. Then compatibilization of 50/50 blend, which gives the superior mechanical properties, was made by using (MA) with ratios (0.5, 1, 1.5 and 2 phr); EO (2.5, 5, 7.5 and 10 phr) and S-BA (2.5, 5, 7.5 and 10 phr) were used, and a study of their effect on all the previous properties were made as well. It was found that, among different rubber blends, the (50/50) NBR/EPDM blend gives the highest rheological, mechanical and thermal characteristics. Using of MAH; EO or S-BA as compatibilizing agents increase the rheological, mechanical and swelling properties and at the same time don't affect the thermal stability of the NBR/EPDM rubber blends. Finally, it is recommended, for the compatibilization of NBR/EPDM, to use 1phr MAH; 5 Phr EO or 5 phr S-BA as these amounts give the optimum rheological, mechanical and swelling properties for the NBR/EPDM rubber blends.

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## List of Symbols and Abbreviations

- AAGR :** average annual growing rate
- AAHR:** aromatic hydrocarbon resins
- ABS:** acrylonitrile butadiene styrene
- ACN:** acrylonitrile
- AMF:** atomic force microscopy
- ASTM:** American society for testing and materials
- AU:** Polyester urethane
- BCC:** Business Communications Company
- BR:** butadiene rubber
- BR:** poly butadiene rubber
- BR:** Polybutadiene rubber
- CBS:** N-Cyclohexylbenzothiazole-2-sulfenamide
- CMC:** carboxy methyl cellulose
- CR:** Polychloroprene rubber
- CSM :** Chloro sulphonated polyethylene
- CSM:** Chlorosulphonated polyethylene
- D:** Diffusion Coefficient(Diffusivity)
- DIPDIS :** bis(diisopropyl)thiophosphoryl disulfide
- DOTG:** Di-o-tolylguanidine
- DPG:** Diphenylguanidine
- DTG:** derivative thermogravimetry
- ECO:** 65/35 Copolymers of epichlorohydrin and ethylene oxide
- ENR :** epoxidized natural rubber
- EPDM:** ethylene propylene diene monomer

**EPR /EPM:** ethylene propylene rubber

**ESO:** Epoxidized soybean oil

**EVA/ EVM:** ethylene vinyl acetate

**EVASH :**ethylene vinyl acetate copolymer functionalized with mercapto

**HNBR:** Hydrogenated Nitrile Butadiene Rubber (HNBR),

**HSN:** Highly Saturated Nitrile

**IIR:** butyl rubber

**IIR:** isobutylene-isoprene rubber

**IR:** isoprene rubber

**M.p:** melting point

**MA /MAH:** maleic anhydride

**MA-g-systems:** maleic anhydride grafted systems

**MAH-g- EPDM:** maleic anhydride grafted with ethylene propylene diene monomer

**MBS:** 2-Morpholinothiobenzothiazol

**MBT:** 2-Mercaptobenzothiazole

**MBTS:** 2,2Dithiobisbenzothiazol

**M<sub>H</sub>:** Maximum torque

**M<sub>i</sub>:** Minimum torque

**MQ:** Methyl-Polysiloxane Silicon rubber

**NBR:** Nitrile Butadiene Rubber

**N-DCBS:** Dicyclohexylbenzothiazole-2-sulfenamide

**NR:** natural rubber

**NRC:** non-reactive compatibilization/compatibilizer

**NR-g-MMA:** natural rubber-grafted-methyl methacrylate

**PA:** polyamide-6

**PBT:** polybutylene terephthalate

**PC:** Polycarbonate

**PCL:** Poly(epsilon.-caprolactone)

**PET:** Polyethylene terephthalate

**Phr:** part per hundred parts by weight

**PMMA:** Polymethyl methacrylate

**PPE:** poly(2,6-dimethyl-1,4-phenylene ether)

**PS-b-PMMA:** Poly Styrene-block-methyl methacrylate

**PVC:** poly vinyl chloride

**RC:** reactive compatibilization

**S:** Sulphur

**S-B block copolymer:** styrene butadiene block copolymer

**SBAH:** polystyrene-hydrolyzed poly(*t*-butyl acrylate) di block copolymer

**SBR:** styrene-butadiene copolymer

**SEBS:** styrene ethylene butylene styrene copolymer

**SEM:** scanning electron microscopy

**Sp.grv.:** specific gravity

**Sulphur MC:** magnesium carbonate coated grade of sulphur

**TBBS:** N-t-butylbenzothiazole-2-sulfenamide

**T<sub>90</sub>:** curing time

**T<sub>g</sub>:** glass transition temperature (T<sub>g</sub>)

**TG:** thermogravimetric analysis

**T<sub>i</sub>:** Onset temperature

**TMTD:** Tetra methyl thiuram disulfide

**TMTM:** Tetra methyl thiuram mono sulfide

**TOR:** trans-poly octylene rubber

**T<sub>p</sub>:** peak temperature