Abstract

Particulate reinforced elastomer composite was prepared by adding reinforcing fillers Al_2O_3 and SiO_2 separately to the two separated matrices; natural rubber (NR) and styrene butadiene rubber (SBR), at different loading levels (0, 5, 10, 15, 20 and 25 pphr). Also many specific tests are performed on these composites. The effects of the variables (matrix type, fillers type and their loading level) on the mechanical properties which include: ultimate tensile strength, elongation percentage at break, modulus of elasticity, compression modulus, hardness, abrasion wear resistance and rebound resilience were studied. The effect on the physical properties which include: swelling, thermal conductivity, and specific gravity was also studied.

The results showed that the mechanical properties except resilience increased with the addition of both types of reinforcing fillers and with the increase of the loading level of them. Silica fillers increased these properties more than alumina fillers. The results indicate that the natural rubber composite has better mechanical properties than that of styrene butadiene rubber except the hardness and abrasion wear resistance. The largest value of ultimate tensile strength, modulus of elasticity at 100% elongation, percentage of elongation at break, and compression modulus were (**70 MPa, 18 MPa, 350% and 22.7 MPa**) respectively for the natural rubber composite reinforced with 25 pphr of silica fillers. Whereas the maximum resilience percentage was (83.6%) for the natural rubber composite reinforced with 25 pphr of alumina. The minimum resilience was (65.59%) for the styrene butadiene rubber reinforced with 25 pphr of silica.

The styrene butadiene rubber reinforced with 25 pphr of silica has the largest values of hardness and minimum values of abrasion wear rate; which are (85 IRHD and 0.91 mm^3/mm) respectively.

The physical properties are significantly affected by the variables, so that the liquids effect (swelling) was distinctively affected by the loading level of reinforcing fillers, but was not affected significantly by the type of reinforcing fillers and rubbers.

The thermal conductivity was also increased with the addition of the reinforcing fillers and with the increase of the loading level of reinforcing fillers. Alumina fillers increase the thermal conductivity more than silica fillers. The maximum thermal conductivity was (0.44 W/m.ºC) for the styrene butadiene rubber reinforced with 25 pphr of alumina.

The specific gravity for all rubber composite was increased with the increase of loading level of reinforcing fillers.

List of Symbol

Symbol	Description	Unit
T_g	Glass Transition Temperature	**°C**
σ	Stress	**MPa**
P	Load	**N**
A	Cross sectional area	**mm^2**
ε	strain	**---**
$L_\circ$	Original length	**m**
ΔL	Elongation	**m**
K_C	Wear rate	**mm^3/mm**
Δm	Mass loss	**g**
m_1	Mass before immersion in liquid	**g**
m_2	Mass after immersion in liquid	**g**
ρ_C	Density of composites	**g/mm^3**
V_S	Sliding velocity	**m/sec.**
t	Sliding time	**sec.**
Q	Thermal flux	**W/m^2**
k	Thermal conductivity coefficient	**W/m.°C**
T	Temperature	**°C**

Symbol	Description	Unit
i	Electric current	**A**
v	Voltage	**V**
r	Radius of disk	**mm**
e	Heat loss per unit time (sec.) through the cross sectional area (m^2) and temperature difference between the disc and environment.	**$W/m^2.^oC$**
d	Thickness of disk	**mm**
Sp.Gr.	Specific gravity	**---**
W	Material mass	**g**

List of Abbreviations

Symbol	***Description***
ASTM	American Society for Testing Materials
Al_2O_3	Alumina
BIIR	Bromo Butyl rubber
BR	Butadiene Rubber
BS	British Standard
CBS	N-cyclohexyl-2-benzothiazole sulfonamide
CCC	Carbon-Carbon Composite
CIIR	Chlorinated Butyl Rubber
CMC	Ceramic Matrix Composite
CR	Chloroprene Rubber (Neoprene)
CTP.100	N-cyclohexyl- thiophthalimide
CV	Conventional Vulcanization
DHP	DiHydroPyridine
EPDM	Ethylene Propylene Di-Methyl
ESBR	Emulsion Styrene Butadiene Rubber
EV	Efficient Vulcanization
FASi	Fly Ash Silica
FRP	Fiber Reinforced Polymers
HAF	High Abrasive Furnace
HAF-HS	High Abrasive Furnace-High Structure
IR	Isoprene Rubber

Symbol	*Description*
IIR	Butyl Rubber
IRHD	International Rubber Hardness Degree
IMC	Inter Metallic Matrix Composite
LDPE	Low Density Polyethylene Rubber
MMC	Metal Matrix Composite
MQ	Silicon Rubber
MOD100	Modulus at 100% elongation
MOD200	Modulus at 200% elongation
MOD300	Modulus at 300% elongation
MBTS	Dibenzthiazyl Disulphide
NR	Natural Rubber
NBR	Acrylonitrile Butadiene Rubber
PPD	N-(1,3-dimethybutyl)-N-phenyl-p- phenylenediamine)
PSi	Precipitated Silica
pphr	part per hundred rubber
PSAS	Polysulfurizedalkoxy Silane
PMC	Polymer Matrix Composite
PVC	Poly Phenyl Chloride
PS	Polystyrene
PE	Polyester
RRP	Recycled Rubber Powder
SAF	Semi-Abrasive Furnace

Symbol	*Description*
SBR	Styrene Butadiene Rubber
SIBR	Styrene Isoprene Butadiene Rubber
SiO_2	Silica
SiC	Silicon Carbide
SIR	Styrene Isoprene Rubber
SMR	Standard Malaysian Rubber
SRF	Semi-Reinforcement Furnace
SSBR	Solution Styrene Butadiene Rubber
TMTD	Tetramethyl Thuram Monosulphide
TMQ	Polymerized(2,2,4-trimethyl1-1,2-dihydroquinomline)
UV	Ultra Violet light
vol %	Volume Fraction Percentage