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# Transport performance in novel elastomer nanocomposites: Mechanism, design and control

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## ABSTRACT

Functional elastomer nanocomposites have found numerous applications in diverse hi-tech areas. Transport phenomena, such as electrical conductivity, thermal conductivity and gas/liquid barrier properties, have been the major focus of functional elastomer nanocomposite research. Despite essential progress in these areas, a summary and discussion of state-of-the-art strategies for regulating the transport performances of nanocomposites based on the transportation mechanisms of electrons, phonons and mass are lacking. In the present review, a brief introduction of transport mechanisms in elastomer nanocomposites precedes a systematic summary of the important progress in elastomer nanocomposites with electrical/thermal conductivities and lowered mass permeabilities, with emphasis on the latest structural control strategies for tuning transport properties. Key applications of functional elastomer nanocomposites related to transport phenomena are also introduced. Overall, this review summarizes the state of the art in the design and performance enhancement of elastomer nanocomposites based on the relationships between their structures and transport properties, governed by the components/composition, interface/dispersion and fabrication.

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## Nomenclature

### Elastomers

ACM	acrylate rubber
BIIR	brominated isobutene-isoprene rubber
BIMSM	brominated poly(isobutylene-co-para-methylstyrene)
BR	butadiene rubber
CIIR	chlorinated isobutene-isoprene rubber
CR	chloroprene rubber
EPDM	ethylene-propylene-diene monomer rubber
EVM	ethylene-vinyl acetate rubber
FKM	fluorinated rubber
HNBR	hydrogenated nitrile rubber
IIR	isobutene-isoprene rubber
IR	cis-polyisoprene
NBR	nitrile rubber
NR	natural rubber
PDII	poly(di-isoamyl itaconate-co-isoprene)
PDMS	poly(dimethyl siloxane)
POE	poly(ethylene-octene) copolymer rubber
PU	polyurethane
SBR	styrene-butadiene rubber
SBS	styrene-butadiene-styrene block copolymer elastomer
SEBS	styrene-ethylene-1-butene-styrene block copolymer elastomer
SiR	silicone rubber

VPR	vinyl pyridine-styrene-butadiene rubber
xNBR	carboxylated nitrile rubber

### Functional fillers

BN	boron nitride
CNFs	carbon nanofibers
CNTs	carbon nanotubes
EG	expanded graphite
GnP <sub>s</sub>	graphene nanoplatelets
GO	graphene oxide
LDH	layered double hydroxide
MMT	montmorillonite
MWCNTs	multi-walled carbon nanotube
ND	nanodiamond
OMMT	organo-modified montmorillonite
REC	rectorite clay
TEG	thermally expanded graphene
VGCF	vapor-grown carbon fiber

## 1. Introduction

Functional elastomers combine the unique high elasticity of elastomers and different functionalities. Functional elastomers relevant to transport phenomena can transport electrons/phonons or retard mass transport, corresponding to electrically conductive, thermally conductive and barrier elastomers. These elastomers constitute the largest class of functional elastomers and have found numerous important

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