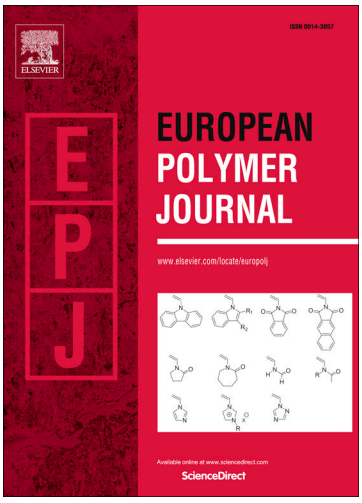
Accepted Manuscript

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E. Helal, C. Pottier, E. David, M. Fréchette, N.R. Demarquette

PII: S0014-3057(17)31827-X
DOI: https://doi.org/10.1016/j.eurpolymj.2018.02.004
Reference: EPJ 8278

To appear in: *European Polymer Journal*

Received Date: 16 October 2017
Revised Date: 29 January 2018
Accepted Date: 3 February 2018

Please cite this article as: Helal, E., Pottier, C., David, E., Fréchette, M., Demarquette, N.R., Polyethylene/ Thermoplastic elastomer/Zinc Oxide nanocomposites for High Voltage insulation applications: dielectric, mechanical and rheological behavior, *European Polymer Journal* (2018), doi: https://doi.org/10.1016/j.eurpolymj.2018.02.004

# Polyethylene/Thermoplastic elastomer/Zinc Oxide nanocomposites for High Voltage insulation applications: dielectric, mechanical and rheological behavior

E. Helal[1], C. Pottier[1], E. David[1], M. Fréchette[2,a], N.R. Demarquette[1,*]
[1]*Mechanical Engineering Department, École de Technologie Supérieure, Montréal, Canada*
[2] *Institut de Recherche d'Hydro-Québec, Varennes, Canada*
[a] *Current affiliation: State Key Laboratory of Electrical Insulation and Power Equipment, Xi'an Jiaotong University, China*
**e-mail: NicoleR.Demarquette@etsmtl.ca*

## Abstract

Blends of polyethylene (PE) with nanocomposites of polystyrene-*b*-poly(ethylene-*co*-butylene)-*b*-polystyrene grafted maleic anhydride (SEBS-MA) thermoplastic elastomer filled with Zinc Oxide (ZnO) nanoparticles have been studied as potential candidates for applications in HV insulation systems including HVDC cables. In particular, the dielectric and mechanical properties of PE/SEBS-MA/ZnO blend nanocomposites have been evaluated and compared to those of PE/ZnO homopolymer nanocomposites prepared as a reference. PE/ZnO materials were characterized by homogeneous distribution of nanoparticles and presence of agglomerations attributed to insufficient compatibility between the metal oxide nanoparticles and the polyolefin matrix. However, nanoscale dispersion was achieved in SEBS-MA/ZnO and PE/SEBS-MA/ZnO nanocomposites due to improved compatibility between the nanoparticles and SEBS-MA. Besides, in PE/SEBS-MA/ZnO blend nanocomposites, ZnO nanoparticles remained exclusively confined in SEBS-MA or at the interface between PE and SEBS-MA. In terms of dielectric properties, the unfilled blend PE/SEBS-MA featured reduced breakdown strength and resistance to surface erosion by partial discharges in comparison with neat PE. However, upon addition of ZnO the blend PE/SEBS-MA presented higher performance when compared to PE. At 1 wt% ZnO loading, the resistance to surface erosion of PE/SEBS-MA increased by 45% higher than neat PE/SEBS-MA, 38% higher than unfilled PE and 30% higher PE/ZnO nanocomposite containing the same ZnO loading. Besides, blend nanocomposites exhibited dielectric losses lower than PE/ZnO nanocomposites at power frequencies and temperatures up to 80 °C. The breakdown strength of both sets of nanocomposites decreased compared to unfilled materials, at large loadings of nanoparticles. However, smaller reduction was observed in the case of PE/SEBS-MA/ZnO nanocomposites due to improved nanoparticles dispersion. Finally, PE/SEBS-MA/ZnO nanocomposites featured enhanced mechanical flexibility when compared to PE/ZnO nanocomposites.

**Keywords:** thermoplastic elastomer, polymer blend nanocomposite, nanodielectrics, selective nanoparticles dispersion, HV insulation systems…

## I. Introduction

Thermoplastic materials such as Polyethylene (PE) and Polypropylene (PP) are common materials used within high voltage insulation systems. Among them, low density polyethylene (LDPE) has been widely used in cable insulation due to its excellent dielectric properties and attractive processability. However, LDPE has relatively poor thermal and mechanical stability at high temperatures which could be improved by crosslinking, for instance. Therefore, currently LDPE is mainly used in its cross-linked form (XLPE), which is unfortunately unrecyclable[1]