# PROGRESS IN THE FIELD OF NANODIELECTRICS: POTENTIALITY FOR HV CABLE APPLICATIONS

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## ABSTRACT

*Commented information is provided on the origins and nature of nanodielectrics, on recent developments relative to polymer nanocomposites, on future needs for cable developments and findings about nano-PE and XLPE, and preliminary results concerning PE coated with nanosilica are reported in turns, to give a feeling of the progress in the field of nanodielectrics and a sense of what could be the potentiality for HV cable applications.*

## KEYWORDS

Nanodielectrics, Polymer nanocomposites, Future cables.

## NANODIELECTRICS IN RETROSPECT

When introduced in 2001, the concept of nanodielectrics [1] was the resulting answer to the questioning "What was in nanotechnologies for electrical insulation?" Fantasizing over the sum [Nanotechnology + Dielectrics], were we to get something special in terms of solid new dielectric materials? These ideas were debated at the turn of the century and reported in the literature [2]. It was recognized that a new class of materials was emerging.

Back then, the nanodielectrics have been defined as consisting of a multi-component dielectric possessing nanostructures, the presence of which resulting into the change of one or several of its dielectric properties. Nanodielectrics would be found in two material categories of interest: ceramics and polymers. The above definition still bears today its full wings. Some subtleties underlie the definetion; an interesting account of these was detailed in [3]. There are many aspects to be considered. Besides the presence of nanostructuring elements, often are neglected the importance of the necessary presence of relevant processes at the nanoscale and the integrable nature of phenomena resulting into macroscopic observables.

First, novelty in properties was hoped for. This achievement lags in time for many reasons. One major refraining element is the lack of quality control of the prepared materials. Also, more importantly, the technical impossibilities for now to attain a high degree of self-assembly with materials useful for electrotechnical applications.

Table 1 presents such a tentative scaling where the perceived order in matter resulting from nanostructuration is taken as a classifying parameter. Novelty is believed to be associated with higher degrees of self-assembly. So far, the nanodielectrics that raised interest consist mainly of a polymer matrix with the addition of an inorganic phase. Although at start the phase consists of nanoparticles, compounding the different ingredients to a final material often results into the presence of multiple heterogeneous regions. Indeed, structural analysis often permits to detect some micrometric-size agglomerates. To this effect, Fig. 1

**Table 1: Appreciative scaling according to the degree of self-assembly; modified from [4]**

| Polymer composite situation | Degree of self-assembly |
|---|---|
| Dendrimer and Supramolecular assembly | 9,0 – 10,0 |
| Synthesis-driven and Sol-gel e.g. in situ polymerization | 5,0 - 7,0 |
| Exfoliation and POSS and Mimicing nanoceramics and Nanostructured microcomposites | 4,0 |
| Adding particles and structures of nanometric size | 2,5 |
| Adding aggregates of nanofillers | 1,0 |
| Polymer blending | 0,5 |
| Doping and Chemical functionalization | 0 |

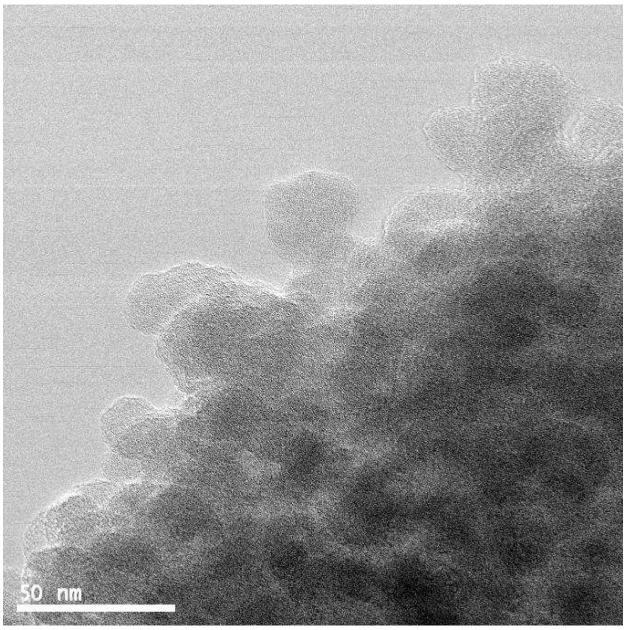


**Fig. 1: TEM micrograph showing nanometric structures on agglomerated silica in PE nanocomposite**