POLYMER MATRIX/CERAMIC INCLUSIONS NANODIELECTRICS FROM MULTIFUNCTIONAL TO SMART PERFORMANCE: ANSWERS AND QUESTIONS

G. C. Psarras

Smart Materials & Nanodielectrics Laboratory, Department of Materials Science,
University of Patras, Patras, 26504, Hellas
** G.C.Psarras@upatras.gr*

ABSTRACT

Polymer matrix nanocomposites constitute a class of enrgineering materilas with continuously increasing impact because of their tunable properties/adjustable performance and applications. As nanodielectrics are referred: (a) polycrystalline semiconducting or insulating materials, with grain diameter at the nanoscale level and (b) polymer composites incorporating nanoinclusions.

Functional materials have the ability to execute certain functions/operations under the influence of an external stimulus or sign control [1]. Stimuli responsive materials, employed as the reinforcing phase in polymers, augment the spectrum of the composites' performance by adding functional bahaviour. Polar oxides are a characteristic example of functional materials by exhibiting tunable polarization, related to their piezoelectric and/or ferroelectric behaviour. Moreover, nanoinclusions can be considered as a distributed network of capacitors, where energy can be stored and retrieved [2-6]. Multifunctionality is the combination of various desirable properties in a material or materials' system, targeting to develop a single material/system exhibiting all necessary responses under various loading conditions at service. Mechanical sustainability, suitable thermal response, tunable electric conductivity, variable electric polarization and dielectric permittivity, magnetic properties, thermally induced phase changes could be parts of the overall multifunctional behaviour. Moreover, materials exhibiting smart performance are expected to be able to tune their behaviour responding to an external or internal stimulus. Certain properties of these systems can be varied in a controllable way, such as stiffness, shape, damping capacity, natural vibration frequency, polarization, conductivity, energy storing efficiency etc. Smart materials are systems incorporating functional constituents being able to perform the operations of sensing, actuation and control [1-6].

In this study, polymer matrix/ceramic inclusions (i.e. polar oxides, ferrites, carbon allotropes) nanocomposites are fabricated and studied. Morphology, thermal properties, static and dynamic mechanical behaviour, dielectric response, conductivity, magnetic properties and induced multifunctionality are investigated via several experimental techniques. The optimum type/types and amount of filler/fillers, the occurring constituents' synergy and physical mechanisms are analyzed and discussed.

The research work was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "First Call for H.F.R.I. Research Projects to support Faculty members and Researchers and the procurement of high-cost research equipment grant" (Project Number:2850).

KEYWORDS: Nanodielectrics, Thermomechanical properties, Magnetic behaviour, Energy storage, Multifunctionality.

REFERENCES

[1] Psarras, G. C., (2014). *Smart Materials,* Patras University Press, Patras.

[2] Patsidis, A., & Psarras, G. C. (2008). *Express Polym. Lett*. 2:718-726.

[3] Patsidis, A. C., & Psarras, G. C. (2013). *Smart Materials and Structures*, 22:115006.

[4] A. Sanida, S.G. Stavropoulos, Th. Speliotis, & G.C. Psarras. *Polymer*, 120 :73-81, 2017.

[5] Manika G.C., Andrikopoulos K.S., & Psarras G.C. (2020). *Molecules*, 25:2686.

[6] Sanida A., Stavropoulos S.G., Speliotis Th., & Psarras G.C. (2021). *Polymer*, 236:124311.