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Editorial corner – a personal view

Polymer nanocomposites and transport (in their) properties

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Nowadays, the scientific and technological impact of polymer matrix nanocomposites is well recognized and appreciated globally, and no arguments are needed to be provided. Besides mechanical properties the technological evolution and the level of everyday life, at least in the developed world, is based on the transport properties of solid materials (metals and alloys, ceramics, glasses, polymers, and composites). In the field of solid-state physics, transport properties refer to electrical, thermal, and magnetic properties of materials.

However, current technological demands from engineering materials include the ability to respond in real time to a rapidly varying environment. By these means, nominal and standard values of various materials' properties do not address these requirements. Novel materials should integrate functionality and exhibit controllable/adjustable behaviour under different conditions and stimuli. The key performance is multi-functionality, which can be considered as the combination of different desirable properties in a single materials' system, exhibiting all necessary responses under various loading conditions at service. Mechanical sustainability, suitable thermal response, tunable electric conductivity, variable electric polarization/dielectric permittivity, magnetic properties, thermally induced phase changes should be parts of the overall multi-functional behaviour.

Under this point of view 'transport' could acquire an additional meaning. Transport (switching) of the properties, under control, between different states and responses, or even better adjusting properties to the applications demands in a wide range of performance.

Hybrid polymer nanocomposites integrating reinforcing phases with diverging/complementary properties, such as carbon forms, polar/ferroelectric oxides, and magnetic particles have been proved able to address these demands. The reinforcing phases' type and amount, the synergy between inclusions, and between matrix and inclusions are the key parameters which lead to enhanced and adjustable mechanical, thermal, electrical, optical, and magnetic performance, in tandem with the ability to store and retrieve energy and information. The target of this research trend is the development of materials/devices, which should be manufactured easily, at low cost, and their components will execute their functions autonomously in relation to each other, responding to environmental stimuli or control signals. Social benefit is expected to include the usage of lower quantities of materials, consuming of lower energy for the shaping and operation of devices, better exploitation of energy, lower environmental footprint, and opening of new horizons in the communication and working ways between mankind itself, and mankind and devices.

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