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“Temperature and Electrical Memory of Nanocomposites”

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Shape Memory Polymers (SMPs) are used in various applications from packaging and heat shrink tubing through various deployable structures. More futuristic uses in medicine and aircraft industries are expected provided that SMPs can involve greater energy density and functions. SMPs are generally deformed at high temperature (T_d) and then cooled down under fixed strain, thus storing mechanical energy. Upon reheating, in the vicinity of the glass transition temperature (T_g), the polymer chains become mobile and the material relaxes by reverting towards its original shape. Polymers can sustain large strain deformation. However, these large deformations are often associated to a low stress. Consequently the combination of stress and strain results in a low gravimetric energy density. Several features of their behavior are empirically tuned by varying the chemical composition of the polymer. More quantitative dependences and generation of giant stress have been recently reported in polymer nanocomposites made of polymers loaded with carbon nanotubes. It has also been observed that the stress generated when the polymer is heated up at fixed strain exhibits a maximum at a temperature close to T_d . This dependence reflects an accurate “temperature memory” of the polymer. This feature allows smarter SMPs to be developed. Such materials are in addition electrically conductive and can be stimulated by Joule’s heating. Their energy density approaches that of the best metallic alloys which are much more costly and 6 times heavier. The recent progresses in the field open therefore a route towards a new class of light and strong actuator materials.

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