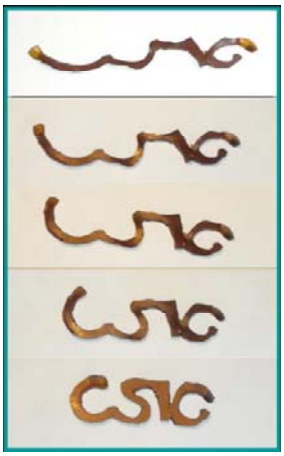
New smart elastomeric materials with thermal stimuli response

The Spanish National Research Council has developed an elastomeric material formed by interpenetrated ionic and covalent networks with shape memory effect which allows to respond to thermal stimuli. For the first time a memory effect is achieved in elastomeric materials due to the coexistence of ionic and covalent networks. The ionic network fixes the transitory shape whereas the covalent network enables the recovering of the initial shape. There is a wide range of applications of these materials such as: artificial muscles, intelligent weaves, biomedical devices, sensors, actuators or intelligent packing.

An industrial partner for a license agreement is sought

Ionic transition: a switch to shape memory effect

Memory shape effect materials are able to change their shape under external stimulus, commonly under thermal stimulus. Elastomers, in spite of its high elasticity, don't exhibit shape memory effect. Recently, The CSIC has developed smart elastomers formed by interpenetrated ionic and covalent networks. These materials show shape memory effect thermally stimulated. The covalent network, thermally stable, is the responsible of the elastic properties that promote the original shape recovery, whereas the thermally sensitive ionic network contributes to fix the temporary shape. The thermal lability of ionic bonds, characterized by the ionic transition temperature, behaves as switching transition. Above the ionic transition, ionics bonds are not effective; therefore, the material can be deformed to a temporary shape. Cooling down the shape memory polymer below its ionic transition temperature, the ionic bonds recover their effectiveness fixing the temporary shape. Finally, a further temperature increase above the transition temperature causes the imbalance strength between the ionic and covalent networks, leading to the recovery of the original shape stored by the permanent covalent network.



Shape recovering of carboxylated nitrile rubber (XNBR) after being deformed to transitory shape and following a temperature increase over ionic transition temperature.

Main applications and advantages

- **Low capital investment:** since the production and characterization of these smart materials are performed by means of conventional methods of rubber processing.
- **Tailor-made properties:** shape memory properties can be modulated according to the required properties in the finished product (different polymers, crosslinking agents, composition, temperature, deformation, etc. can be used).
- **Reproducibility and repeatability:** shape memory characteristics remain invariant throughout several cycles of programming and recovery of the original shape.
- **Wide range of applications:** actuators, sensors, artificial muscles, intelligent weaves, intelligent packing and biomedical devices.
- **High raw material availability:** commercial polymers are used.

  Environmentally friendly: no solvents are used.

Patent Status

Spanish patent and PCT international applications filed.

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