Suplemento de la Revista Latinoamericana de Metalurgia y Materiales, 2009, **S2** (1): 13

SELF-HEALING SUPRAMOLECULAR RUBBERS

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Trabajo remitido pero no presentado en el XIII COLOQUIO VENEZOLANO DE POLÍMEROS, 11 al 14 de Mayo de 2009 (Naiguatá, Venezuela).

Selección de trabajos a cargo de los organizadores del evento.

Disponible en: *www.polimeros.labb.usb.ve/RLMM/home.html*

Supramolecular chemistry can help solve the dilemma of having easily processable material with good polymer-like properties and thereby contribute to some important societal issues of 21st century.

My lecture will try to answer the question of how small molecules can exhibit polymer-like properties thanks to directional interactions, and in particular whether they can show rubber-like behaviour.

Rubbers exhibit enormous extensibility up to several hundred percent compared with few percent for ordinary solids and ability to recover their original shape and dimensions on release of stresses. Rubber elasticity is a property of systems consisting of macromolecules either covalently cross-linked or connected together by thermoreversible physical associations. I will discuss design principles and synthesis of molecules that associate via hydrogen bonds to form materials that show recoverable extensibility up to several hundred percent. In striking contrast to conventional cross-linked or thermoreversible rubbers made of macromolecules, these systems when broken or cut can be simply mended by bringing together fractured surfaces to self-heal at room temperature. Repaired samples recover their enormous extensibility. The process of breaking and healing can be repeated many times. At high temperatures these materials flow and resume their rubber elasticity upon cooling. They can thus be easily processed, reused and recycled. Unique self repairing properties, the simplicity of the synthesis, the availability from sustainable resources and low cost of raw ingredients, fatty acids and urea bodes well for future applications for these materials. The versatility of the system is not only an asset for industrial development but also offers an interesting playground to better understand the challenging physics of unusual elasticity, glass-like dynamics and relaxations, adhesion and supramolecular structures formation.