Thermally Responsive Diels-Alder Materials as Potential Heat Storage Systems for the Protection of Electronic Devices

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Abstract

Temperature peaks during processing of electronic circuits (e.g. soldering) or even during normal operation could result in irreparable damages and incur in high operational costs. Current research at Fraunhofer UMSICHT focuses on the development of reversible polymeric solid organic materials based on Diels-Alder reactions for thermochemical energy storage at moderate temperatures, which are able to cope with high short-term temperature peaks (~ 200°C) in electronic devices, thus acting as a thermal buffer. Among various adequate reaction types for solid-phase materials, the Diels-Alder cycloaddition reaction was chosen as a promising thermoreversible reaction for heat storage [1]. The reaction of a furan resin with different maleimides was study under various conditions in order to tune the temperature range for the retro-Diels-Alder reaction. These polymeric materials can be applied as a protecting coating but due to the low surface densities achieved it was necessary the production of circuit boards with the embedded material by means of a custom-made apparatus. The characterisation of such organic materials with thermoanalytical methods like DSC and TGA, alone or in combination with ATR-IR delivers information about their heat capacity, thermostability and reversibility. It was found out that such polymeric systems undergo adverse side reactions at temperatures above 150°C, such as crosslinking and aromatization [2], thus compromising reversibility. In order to extend the buffering effect to higher temperatures without losing reversibility, an anthracene-based system was identified to work well in the temperature range 120-250°C.

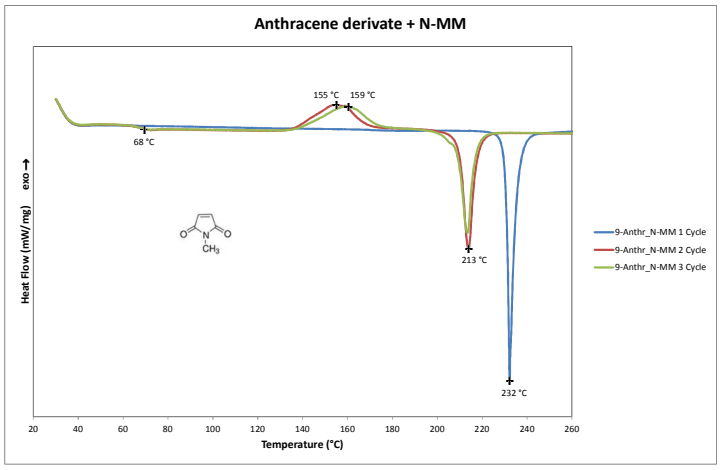

Figure 1: DSC thermogram of the Diels-Alder adduct between the anthracene derivate and N-Methylmaleimide

The synthesis of high-purity Diels-Alder adducts between the anthracene derivate and maleimides was carried out in aqueous media since it is on the one hand a green chemistry method and on the other hand it is known that water exhibits a catalytic effect [3], thus reducing drastically the reaction time.

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[3] R. Breslow and J. Carmelo, *J. Am. Chem. Soc.* **113** (1991) 4340–41.