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Synthesis of Microencapsulated Phase Change Material for Adhesives with Thermoregulating Properties

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Abstract : Due to environmental regulations on greenhouse gas emissions and the depletion of fossil fuels, there is an increasing interest in electric vehicles.To maximize their driving range, batteries with high storage capacities are needed. In most electric cars, rechargeable lithium-ion batteries are used because of their high energy density. However, it has to be taken into account that these batteries generate a large amount of heat during the charge and discharge processes. This leads to a decrease in a lifetime and damage to the battery cells when the temperature exceeds the defined operating range. To ensure an efficient performance of the battery cells, reliable thermal management is required. Currently, the cooling is achieved by heat sinks (e.g., cooling plates) bonded to the battery cells with a thermally conductive adhesive (TCA) that directs the heat away from the components. Especially when large amounts of heat have to be dissipated spontaneously due to peak loads, the principle of heat conduction is not sufficient, so attention must be paid to the mechanism of heat storage. An efficient method to store thermal energy is the use of phase change materials (PCM). Through an isothermal phase change, PCM can briefly absorb or release thermal energy at a constant temperature. If the phase change takes place in the transition from solid to liquid, heat is stored during melting and is released to the ambient during the freezing process upon cooling. The presented work displays the great potential of thermally conductive adhesives filled with microencapsulated PCM to limit peak temperatures in battery systems. The encapsulation of the PCM avoids the effects of aging (e.g., migration) and chemical reactions between the PCM and the adhesive matrix components. In this study, microencapsulation has been carried out by in situ polymerization. The microencapsulated PCM was characterized by FT-IR spectroscopy, and the thermal properties were measured by DSC and laser flash method. The mechanical properties, electrical and thermal conductivity, and adhesive toughness of the TCA/PCM composite were also investigated.

Keywords : phase change material, microencapsulation, adhesive bonding, thermal management
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