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Influence of the magnetization of thermally expandable particles on the thermal and debonding properties of bonding joints

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Abstract-

This study addresses the challenge of recycling adhesive bonds, as their disassembly is irreversible and damages the substrates. It explores the use of thermally expandable particles (TEPs), which, when heated, expand and weaken the bond. The magnetization of TEPs allows us to control their distribution using a magnetic field. The work aims to obtain magnetized TEPs, study their influence on resin curing, mechanical performance, and durability, test their mobility in graded bonds, and analyze the temperature-induced debonding process. TEPs are characterized using various techniques, including differential scanning calorimetry, nuclear magnetic resonance, and scanning electron microscopy. Additionally, the impact of 25 wt.% TEPs on epoxy resin curing is examined using the Kamal model. Adhesion and disassembly assessments were conducted through tensile shear tests using single-lap-joint specimens, while the bond durability was determined via wedge testing. It was found that magnetization reduces the debonding time, though it decreases shear strength while increasing bond durability. The crack formation energy is higher with magnetic TEPs, and total crack length is lower in long-term wedge tests. Once debonded, the substrates are sanded and reused as raw material.

Index Terms- thermally expandable particles; magnetic thermally expandable particles; adhesive joints; debonding; durability; wedge test

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