

Investigation of Adhesive and Electrical Performance of Waterborne Epoxyes for Interlayer Dielectric Material

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Materials Engineering Science

(Abstract)

The primary differences between the solventborne and waterborne epoxy printed circuit board (PCB) impregnating resins arise from the distinct physical compositions and drying characteristics of the polymer solution and the latex emulsion. The presence of residual surfactant from the waterborne epoxy emulsion poses a concern for dielectric performance and adhesive durability. Another problem involves the crystallization of insoluble solid dicyandiamide (DICY), which is significantly different in morphology than that found in solution cast resins.

A two-stage drying model was employed to gain a better understanding the drying and coalescence processes. The process of surface DICY crystal formation during the drying of glass prepreg sheet was related to a threshold concentration of the curing agent in the impregnating latex resin formulation. Conditions favoring faster drying lead to the rapid formation of a coalesced skin layer of latex resin, thereby trapping the curing agent in the bulk and reducing the surface deposition of DICY by percolating water. Surfactant is believed to remain concentrated in a receding wet zone until it is driven to the surfaces of the glass fibers upon the completion of drying.

The copper foil/laminate interface was evaluated by a 90° peel test as part of two different studies: an analysis of the viscoelastic response of the interface during peel and a study of the thermal durability of the copper/laminate interfacial peel strength. The surfactant acted as a plasticizer to toughen the fiber/matrix interphase, resulting in larger observed peel strengths in the latex resin impregnated materials relative to the solventborne system. Surfactant segregated to the fiber surface during coalescence to form a plasticized fiber/matrix interphase; surfactant migrated into the bulk during postcure to yield a more homogeneously plasticized epoxy matrix.

Dielectric measurements of neat resin and laminate materials revealed that the dielectric constants of the model resin-impregnated laminates met the performance criteria for PCB substrates of their class, regardless of surfactant content.

Overall, the adhesive performance, adhesive durability, and dielectric properties of PCB systems fabricated with model latex epoxy resin, containing native surfactant (5 wt %), met or exceeded the performance of an equivalent solventborne resin impregnated system.

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