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Characterizing Corrosion Effects of Weak Organic Acids Using a Modified Bono Test

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To meet environmental requirements and achieve benefits of cost-effective manufacturing, no-clean fluxes (NCFs) or low-solids fluxes have become popular in present electronic manufacturing processes. Weak organic acids (WOAs) as the activation ingredients in NCFs play an important role, especially in the current lead-free and halogen-free soldering technology era. However, no standard or uniform method exists to characterize the corrosion effects of WOAs on actual metallic circuits of printed wiring boards (PWBs). Hence, the development of an effective quantitative test method for evaluating the corrosion effects of WOAs on the PWB's metallic circuits is imperative. In this paper, the modified Bono test, which was developed to quantitatively examine the corrosion properties of flux residues, is used to characterize the corrosion effects of five WOAs (i.e., abietic acid, succinic acid, glutaric acid, adipic acid, and malic acid) on PWB metallic circuits. Experiments were performed under three temperature/humidity conditions (85°C/85% RH, 60°C/93% RH, and 40°C/93% RH) using two WOA solution concentrations. The different corrosion effects among the various WOAs were best reflected in the testing results at 40°C and 60°C. Optical microscopy was used to observe the morphology of the corroded copper tracks, and scanning electron microscopy (SEM) energy-dispersive x-ray (EDX) characterization was performed to determine the dendrite composition.

Key words: Weak organic acid, Bono test, no-clean flux, dendrites, electrochemical migration, copper corrosion test

INTRODUCTION

Currently, no-clean fluxes or low-solids fluxes (LSFs) are widely used in the electronics industry. One driving force behind the development of no-clean fluxes is environmental. Traditional rosin-based fluxes were cleaned with solvents containing chlorofluorocarbons (CFCs) that were very effective and nontoxic. However, due to concerns over stratospheric ozone depletion, these compounds are no longer allowed, as dictated by the Montreal Protocol[1] and later the Clean Air Act.[2] In no-clean fluxes, a key active ingredient is a weak organic acid (WOA). It has been shown that the residues of some WOAs have a detrimental effect on the surface insulation resistance (SIR)[3] of PWBs under diverse environmental conditions.[4–8] In one study,[4] the effect of four WOAs on SIR[3] was investigated under a variety of temperature/humidity conditions. Differences in SIR values among the WOAs were evident at low temperature. In another study,[5] dicarboxylic acid remaining on the substrate after exposure was analyzed by dynamic ionic contamination analysis. The results indicated that more than 90% of these activators had disappeared within a day at 85°C, and so it was suggested that 65°C or 50°C may be a better temperature for SIR

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