# Research on new high-end, environmentally friendly and efficient leveling agent for electroplated copper

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In the field of electronic manufacturing today, high-end electroplating technology plays a crucial role as the only means to achieve nanoscale electronic interconnections. In the manufacturing of high-density interconnect printed circuit boards (HID-PCBs), defect-free copper interconnects are the key to ensuring reliable electrical connections and signal transmission integrity. The key to achieving perfect filling of blind holes in PCBs lies in the effective application of electroplating additives to precisely control the copper deposition process. Levelling agents are core additives in the electroplating of copper blind holes. Therefore, to meet the design requirements, this study is dedicated to developing a new levelling agent that is environmentally friendly, exhibits excellent performance, and is cost-effective. A comprehensive study will be conducted on the mechanism of action during the electroplating process and the performance of the copper coating after electroplating. Small nitrogen-containing heterocyclic compounds have become a hot topic in the research of new levelling agents due to their low cost, low toxicity, and stable electroplating performance. Based on 2-mercapto-5-methyl-1,3,4-thiadiazole (MMT), this study aims to design and synthesize a new environmentally friendly compound, 2-(benzylthio)-5-methyl-1,3,4-thiadiazole (BMT), as a novel levelling agent for copper electroplating in blind holes. The raw materials used for synthesis are simple, easily accessible, and the synthesis steps are relatively simple. The synthesis of the new additive was confirmed by proton nuclear magnetic resonance spectroscopy. Quantum chemical calculations, molecular dynamics simulations, and other methods were used to determine that the compound BMT exhibits strong adsorption properties on the copper surface, with an adsorption energy of -90.39 Kcal/mol. Electrochemical tests (CV, LSV, GMs) were conducted to analyse the effect of the compound BMT as a levelling agent on copper deposition behaviour, and the results showed that the compound BMT has strong inhibitory ability on copper electrodeposition. Filling experiments and reliability tests were performed on blind holes with different depth-to-width ratios, and the results showed that the addition of this new levelling agent to the electroplating solution can achieve dense filling of blind holes of different sizes and good coating quality. Finally, in-situ surface-enhanced Raman spectroscopy (EC-SERS) was used to study the mechanism of action of the additive on the copper surface from a microscopic perspective. The comprehensive results indicate that the newly synthesized compound BMT exhibits excellent electroplating filling performance and is suitable as an effective levelling agent for blind hole copper plating.

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References

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