Three-Dimensional (3D) Laser-Induced Surface Metallisation for the Fabrication of 3D Printed Electronics

Reza Nekouie Esfahani[a]*, Aneta Chrostek-Mroza, Tian Long See[a], Chris Powley[a], Maria Fissari[b] and Elmina Kabouraki[b]

[a]*Manufacturing Technology Centre, Pilot Way, Ansty Business Park, Coventry, CV7 9JU, UK*

[b]*Foundation for Research and Technology - Hellas (FORTH), Greece*

Abstract

In today's fast-evolving landscape of portable electronics, wearable tech, LEDs, microelectronics, and bioelectronics, creating metallic circuits on polymer substrates with strong adhesion properties poses a growing challenge. This study successfully fabricated high-resolution metallic circuits on commercial polymer surfaces (CE221 and ULTEM 9085) using laser direct structuring (LDS) with copper acetylacetonate Cu(acac)2 [1,2]. The selective metallization mechanism was systematically explored, with RAMAN Spectroscopy confirming the formation of Cu0 (elemental copper) via photochemical reduction reaction after 1032 nm NIR pulsed laser irradiation. Detailed analysis delved into laser activation and subsequent copper plating mechanisms, along with measuring electrical resistance and surface adhesion of the copper tracks on the polymer. Furthermore, the technology's potential was exemplified through a 555-timer flasher demonstration, showcasing how this process can provide the necessary electrical, mechanical, and thermal properties for future real-world applications in 3D printed electronics.

Acknowledgements:

References:

[1]: Esfahani, R.N., Shuttleworth, M.P., Doychinov, V., Wilkinson, N.J., Hinton, J., Jones, T.D., Ryspayeva, A., Robertson, I.D., Marques-Hueso, J., Desmulliez, M.P. and Harris, R.A., 2020. Light based synthesis of metallic nanoparticles on surface-modified 3D printed substrates for high performance electronic systems. *Additive Manufacturing*, *34*, p.101367.

[2]: Kabouraki, E., Melissinaki, V., Yadav, A., Melninkaitis, A., Tourlouki, K., Tachtsidis, T., Kehagias, N., Barmparis, G.D., Papazoglou, D.G., Rafailov, E. and Farsari, M., 2021. High laser induced damage threshold photoresists for nano-imprint and 3D multi-photon lithography. *Nanophotonics*, *10*(14), pp.3759-3768.