Metallization of Three-Dimensional Complex Structure as Functional Components in Electronic Devices

Tokyo Tech[1], ENEOS Corp.[2], °Po-Wei Cheng[1], Chun-Yi Chen[1], Taku Ichibayashi[1,2], Tso-Fu Mark Chang[1], Masato Sone[1], Suzushi Nishimura[1]

E-mail: Cheng.p.aa@m.titech.ac.jp

Three-dimensional (3D) printing technology has high potentials to be applied in various fields such as fabrication of functional components in electronics, electromagnetics, aerospace, and bioengineering. Especially, 3D printing technology has advantages like versatility in design and fabrication of complex 3D structures, low cost and fast fabrication process time, and flexible selections of the ink material. For application of 3D-printed polymer structures in the electronic devices, metallization of the 3D-printed polymer structure is necessary and could be achieved by electroless plating. However, toxic chemicals are used in conventional electroless plating process for cleaning and roughen surfaces of the substrate to enhance interactions between the substrate surface and the deposited metal coating. Also, the conventional method is not environmentally friendly, and further enhancement of the interaction between the substrate and the metal coating is still needed. Therefore, utilizing supercritical carbon dioxide ($scCO_2$) as the solvent in the catalyzation step of the electroless plating process is proposed for metallization of polymer materials [1]. $ScCO_2$ has properties of non-polar, high self-diffusivity and zero surface tension when the CO_2 reaches the supercritical state above the critical point (7.4 MPa and 31 °C).

In Fig 1. A 3D printed complex structure was successfully metalized by a $scCO_2$-assisted electroless plating process. $ScCO_2$ was used as the solvent in the catalyzation step, and the source of the catalyst was palladium bis-hexafluoroacetylacetonate. Ni-P coatings were deposited on surfaces of the catalyzed 3D-printed polymer structure with a commercially available solution. Electrical resistance of the Ni-P metallized 3D-printed polymer structure was measured, and the adhesion of the Ni-P coating on the 3D-printed polymer structure was evaluated by a tape adhesion test [2]. The electrical resistance was 0.03 Ω and maintained at a low level of 0.04 Ω after the tape adhesion test in Fig 2.

References

[1] Y. Iwai, S. Sameshima, S. Yonezawa, S. Katayama, J Supercrit. Fluids, 100 (2015) 46-51.

[2] P.W. Cheng, C.Y. Chen, T. Ichibayashi, T.F.M. Chang, M. Sone, S. Nishimura, MRS Comm., doi: s43579-021-00022-2

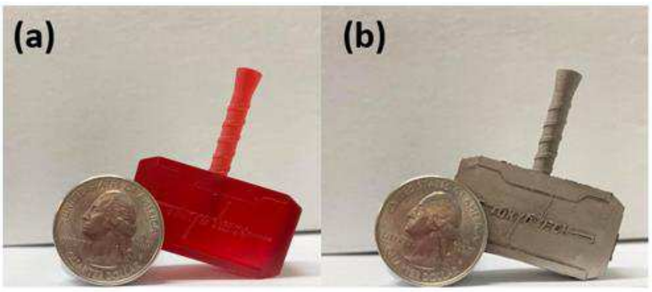

Figure 1 A 3D-printer hammer (a) before and (b) after the metallization process.

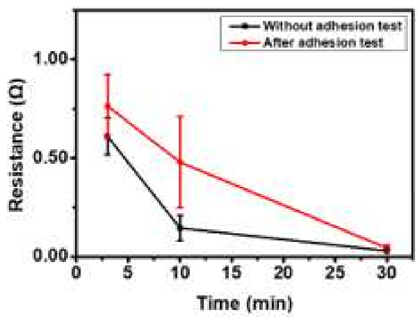

Figure 2. The metal deposition time versus the electrical resistance