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論 文 要 旨

THESIS SUMMARY

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要旨（和文 2000 字程度）
Thesis Summary（approx.2000 Japanese Characters ）

Metallization and functionalization of textile materials are important topics toward the applications of wearable devices such as bio-sensor and e-clothing. The integration of the distinct materials such as polymer, metal, and oxides becomes the greatest challenge. Electroless plating is a promising technique to combine metal materials and non-electrically conductive polymer substrate together. This technique can especially be applied to the substrate with sophisticated structures such as textile. Electroless plating is divided into three major steps, pretreatment is the first step to clean and roughen the substrate, catalyzation is the second step to embed the catalysts into the substrate making the substrate active, and the final step is metallization step to metallize the substrate. In the conventional catalyzation step, the catalysts were only inlaid on the substrate surface due to the polar property of aqueous solution. Supercritical carbon dioxide (sc–CO_2) was introduced into the catalyzation step to solve the aforementioned problems. Since sc–CO_2 owns both the properties of gas and liquid phases, affinity to non–polar material, non-corrosive to most of the polymers, and low surface tension, it thus can bring the non–polar metal–organic complex catalysts (i.e. Palladium(II) acetylacetonate) to go into the polymer substrate and remains the substrate undamaged. In this way, the adhesion between polymer substrate and deposited materials can be improved due to embedment of the catalysts into the substrate. On the other hand, sc–CO_2 can also be introduced into the metallization step to enhance the metallization properties. There are usually hydrogen evolutions during the metallization and the hydrogen bubbles might be embedded into the metallization layer resulting in the defects in the metallization layer. With the help of sc–CO_2 micelle bouncing in the solution, it can carry the H_2 bubbles away and reduce the defects in the metallization layer. Therefore, sc-CO_2 promoted electroless plating (i.e. sc–CO_2 catalyzation and sc–CO_2 metallization) was carried out for the integration of metal and textile materials.

Silk textile, a common cloth material, was chosen in this study on account of its flexibility and stitchability. Ni–P was chosen due to its highly electrical conductivity, high corrosion resistance, and high wear resistance. However, Ni shows allergic issue, Pt and Au were thus chosen to solve the biocompatibility problems. In the meanwhile, Pt and Au also own the highly electrical conductivity, high corrosion resistance, and high wear resistance. In this study, metallization layers of Ni–P, Pt, and Au were integrated with silk textile by the sc–CO_2 promoted electroless plating to achieve the composites toward the applications of flexible wearable devices.

In the meanwhile, the wearable devices are required to be equipped with different functions such as the photovoltaic and photocatalytic devices in response to the requirements of the next–generation technology. There are many materials that can play the role as the photocatalyst in the composite material, such as TiO_2, CuO, and ZnO. ZnO and TiO_2 were chosen for the photocatalytic materials due to their proper band gap energies and low cost. ZnO and TiO_2 were fabricated on the metallized silk textile by the cathodic deposition and co–deposition methods to fulfill the requirements of photocatalytic properties.

The surface morphology, cross–section, and compositions of the silk/metal/oxide composites were examined by an OM, SEM, and EDX. The crystal structures and phases were identified by an XRD. Electrical resistances were evaluated by a four–point probe. Electrical resistance was measured again after the adhesive test conducted by the tape paste/peel–off tests for evaluating the adhesive firmness of the composites. Corrosion resistances were measured by the polarization method in 3.5 wt.% NaCl and simulated body fluid (SBF), respectively. 3.5 wt.% NaCl was for simulating human sweat and SBF was for simulating human body fluid. Biocompatibility was evaluated by the immersion test in the SBF solution. The evaluation of photocatalytic activities were conducted in a three–electrode cell consisting of a Pt counter electrode, Ag/AgCl reference electrode, and a piece of the silk/metal/oxides as the working electrode. The evaluation processes were carried out at room temperature and 1 atm. 0.5 M Na_2SO_4 solution was used as the electrolyte.

Metallized silk textile with proper electrical resistance ranges were fabricated for the applications of wearable devices. The composites show firmly adhesive properties after adhesive tests. Processed silk showed the high corrosion resistances in both 3.5 wt.% NaCl and SBF solutions. Metallized silk textile equipped with ZnO or TiO_2 showed the high photocatalytic activity.