Improvement of coating adhesion ability on magnesium by femtosecond laser surface modification

J Park[1,2], HS Han[1], S Lee[1], J Park[1], YC Kim[1], M OK[1], HK Seok[1], S Chung[2], J Lee[3], H Jeon[1]

[1] *Center for Biomaterials, Biomedical Research Institute, Korea Institute of Science and Technology, Seoul, Korea* [2] *Small+integrative device laboratory, Department of Micro/Nano system, Korea University, Seoul, Korea* [3] *School of Advanced material Engineering, Kookmin university, Seoul, Korea*

INTRODUCTION: Laser surface engineering is emerging as a new tool for micro/nano structure modification of materials due to its simple and effective process. Recently, technology utilizing the femtosecond (fs) laser has been highlighted in the field due to various advantages, which includes laser texturing technique one-step process to easily form macro/nano structure on materials [1]. Changes of surface structure results in alteration of several properties such as roughness, surface energy, and wettability. In this study, surface wettability of Mg was modified into super-hydrophilic state to achieve improvement in coating adhesion using fs laser surface modification method. Modified surfaces were coated with biodegradable polymers and compared with that of pure Mg.

METHODS: Pure Mg strips (Kojindo Japan.) with 99.9% purity were prepared (8 mm x 8 mm x 1 mm) for surface modification. The irradiating laser source was constituted by a regenerative amplified ytterbium (λ=343 nm) delivering 400 fs pulse at a repetition rate of 1 kHz. Average pulsed power was 160 μJ and scan speed was 0.5 mm/s. Poly(L-lactic acid) (PLLA, L 214 S), Poly(lactide-co-glycolide)(PLGA, LG 857 S) were spin-coated on the surface of laser treated Mg.

RESULTS: Top inset images from Figure 1 (a) and (b) shows the difference in microstructures formed by laser modification, which results in significantly different contact angle. Compared non-laser treated control samples, laser treated group shows significantly lower contact angle (Control : 55±10.5º, Laser treated : <10º). This result indicated that the surface property of pure Mg changed into hydrophilic wettability by laser irradiation, which could lead to improvement in adhesion strength of the coating layer at the modified surface. We observed superior adhesion strength and greater contact surface area for both polymer coating on super-hydrophilic Mg. In the immersion test and cell viability test also showed noticeably improved corrosion properties when compared to the control group.

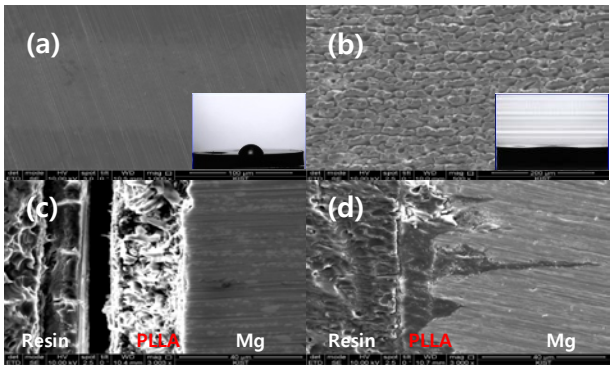

Fig. 1 : Surface profile, and contact angle (inset) of (a) control and (b) laser modified surface and cross-section images of PLLA coating layer on (c) control and (d) laser modified surface.

DISCUSSION & CONCLUSIONS: In this study, through a surface modification using the fs laser texturing, the surface morphology of the Mg was changed into micro/nano structure resulting in improvement of adhesion strength due to imbedded coating layer between pits and grooves. Change in surface structure turned Mg surface property into hydrophilic state, which allowed formation of more adhesive, quicker and denser coating layer using biodegradable polymers. Such technology can be applied in wide range of biomedical application.

REFERENCES: [1]Krüger J, Kautek W (1999) The femtosecond pulse laser: a new tool for micromachining.LASER PHYSICS-LAWRENCE-**9**: 30-40.

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