51 | P A

REDUCING AIR POLLUTION: FABRICATION OF COMPOSITE TITANIUM FOAMS MODIFIED WITH CARBON NANOPARETICLES FOR AUTOMOTIVE CATALYTIC CONVERTERS

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Abstract: Rapidly increasing number of cars is behind abrupt intensification of air pollution harmful for environment and humans' health. Consequently, the effective reduction of emission of air pollutants produced by the vehicle engines is one of the priority research areas. One of several elements of exhaust system that is designed to reduce/terminate the toxic emission is an automotive catalytic converter (ACC). ACC typically consist of a porous substrates coated with precious metals. Various researches indicated that platinum and palladium from the coating released with exhaust can be toxic and/or have deteriorating effect on the environment. For these reasons, there is a growing need for the replacement of those materials in ACC. Several studies showed that good candidates for reduction of emission of air pollutants released by exhaust pipes are carbon nanotubes (CNTs) and graphene oxide (GO) due to their ability to uptake heavy metal ions and toxic chemical compounds, such as NO_x and dioxin. Additive Manufacturing (AM) techniques, such as Selective Laser Melting (SLM) enables fabrication of multifaceted metallic porous substrates used in ACC. To enhance pollution uptakes, metallic substrate can be coated with layers containing CNTs/GO. In our work we have optimized linking between metal porous substrate and CNTs/GO nanoparticles, by implementing calcium phosphates. Coatings were fabricated by electrodeposition, where calcium and phosphate ions mixed with CNTs/GO nanoparticles were deposited directly on the titanium cellular solid. The titanium porous substrates were fabricated on 3D printer by the Selective Laser Melting (SLM) technique. Focused Ion Beam (FIB) microscope was employed for fabrication of thin foils for Scanning Transmission Electron Microscopy (STEM) observations. Scanning Electron Microscopy (SEM) showed calcium phosphates on the whole surface of the chemically polished scaffolds. STEM observations have revealed morphology of fabricated coatings, which was typical for on titanium nano-hydroxyapatite (HAP), namely, connected spherous particles sized 20-70nm. The energy dispersive X-ray analysis (EDX) and X-ray diffraction (XRD) confirmed HAP presence in the fabricated coatings. The microtomogrpahy (μ-CT) has shown porosity between fabricated coating and titanium substrate. Furthermore, our work has confirmed that chemical polishing improves formation and stable attachment of calcium-phosphate on the 3D printed titanium substrates.

Keywords: Titanium, nanoparticles, nanotubes, graphene oxide

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