Plasma Processing
Room Naupaka Salon 4 - Session PS-TuM1

Plasma Modification of Surfaces and Materials

Moderator: Morgan Hawker, California State University, Fresno

8:20am **PS-TuM1-2 Development of Novel High-Entropy-Alloy Powders and Their Plasma-Sprayed Coatings*, Shih-Hsun Chen,*** National Taiwan University of Science and Technology, Taiwan

With our experience in the research and development of metal materials, we will continue to develop various multi-principal high-entropy alloy powder materials and establish their technical capabilities for additive manufacturing. The alloy powders prepared by gas atomization method can ideally present the characteristics of homogeneous high-entropy alloy through the rapid solidification process, and achieve the most suitable process technology for high-entropy alloy products. Combined with the selected additive manufacturing technologies, including plasma spraying and selective laser melting processes, it hopes to implement the application and promotion of high-entropy alloys. The above-mentioned two processes are common and important process technologies in the industry. Although material research continues to innovate, there are not many researchers engaged in the development of thermal spray process technology. In addition, metal 3D printing technology is sprouting and looking for key applications In the current industry. Therefore, this project will rely the established high-entropy alloy powder manufacturing technology, and the development experience of thermal spraying process, focusing on the development of new high-performance AlCrFeNiSi+Y high-entropy alloy powder products and their applications via additive manufacturing technology. Starting from the high-entropy stainless steel alloy (AlCrFeNi), the new elements (silicon and yttrium) are going to be added to improve the quality of the material. It is expected to be developed and built to be suitable for high-temperature environments, with oxidation, corrosion and abrasion resistance. The goal is to develop industrially applicable products and promote them to the industry.

8:40am **PS-TuM1-3 Surface Fenicral Medium-Entropy-Alloy Coating to Enhance High-Temperature Air-Oxidation Resistance of a Plain Carbon Steel*, W. Kai*,** *I. Yang,* National Taiwan Ocean University, Taiwan*; C. Chu,* National Taiwan Ocean University, Taiwan*; S. Chen,* National Taiwan University of Science and Technology, Taiwan*; J. Kai,* City University of Hong Kong

The effect of thermal spraying FeNiCrAl coating (~150 micron thick) on a low carbon steel to enhance oxidation resistance was investigated at 700-900 ^{o}C in dry air.. The oxidation kinetics of both the steel with and witout coating followed the parabolic-rate law, and the oxidation rate constants (k_p values) steadily increased with increasing temperature.It was found that the k_p values of the coating alloy were at least 3 orders of magnitude lower than those of the uncoated carbon steel. The scales formed on the carbon steel consisted of iron oxides (FeO/Fe_3O_4), while an exclusive layer a-Al_2O_3 formed on the coating alloy.The formation of slow-growing a-Al_2O_3 is responsible for the significant reduction of oxidation rates for the coating alloy.

9:00am **PS-TuM1-4 Synthesis of Carbon-Based Thin Films by PECVD and Their Nanostructure Control*, Shinsuke Mori,*** *F. Bohlooli, N. Nedjad, A. ANAGRI,* Tokyo Institute of Technology, Japan

In this study, catalyst-free growth of carbon nanomaterials was performed by plasma-enhanced chemical vapor deposition using CO as a carbon source gas. Microwave discharge system was utilized for this study. The pressure of the discharge was between 20 to 250 Pa and the input power was between 60 to 120 W. The effect of CO: H_2 and CO: O_2 ratio on the morphology of carbon films is investigated. In the microwave discharge system, without an addition of hydrogen, vertically aligned CNFs were synthesized. At lower H_2: CO ratio carbon nanowalls were synthesized, while polycrystalline diamond films were deposited with much higher H_2: CO ratio. We have also synthesized carbon nanowalls from CH_4 and CO_2 gas mixtures and compared their structure, crystallinity, and growth rate with those synthesized by CO and H_2 gas mixtures. The optical emission spectroscopy of the CO/H_2 and CH_4/CO_2 plasma was performed to discuss the reaction mechanism. Scanning electron microscopes and transmission electron microscopes were utilized to examine their nanostructures. Raman spectroscopy and X-ray photoelectron spectroscopy were performed to analyze crystallinity, chemical composition and the bonding state of the film. We have also investigated the effect of electric field on the structure of carbon nanomaterials and the well-parallelized carbon nanowalls were successfully synthesized by the addition of strong electric field near the substrate. The possible mechanism for their growth and control of the nanostructure of carbon nanomaterials is discussed.

9:20am **PS-TuM1-5 Tunable Photoluminescence from Carbon-Based Nanostructures*, Frank Güell,*** Universitat de Barcelona, Spain

Carbon nanostructures such as graphene nanowalls (GNWs) or vertically aligned carbon nanotubes (VACNTs) show an intense and very broad emission band in the visible range from 350 to 850 nm, which also exhibits a tunable luminescence from 450 to 600 nm. The origin of these visible contributions change as a function of the growth conditions and the nanostructures obtained. GNWs were grown by inductively coupled plasma chemical vapor deposition (ICP-CVD) at low-pressure into a tubular reactor under pure methane. VACNTs were obtained by plasma-enhanced CVD (PECVD) and wáter-assisted CVD. Incorporation of oxygen and nitrogen functional groups by oxygen-plasma, water-plasma and nitrogen-plasma changes the photoluminescence properties of the carbon nanostructures. The understanding of these processes provides additional criteria for designing nanomaterials based on carbon, which is environmentally friendly for optoelectronics applications.

9:40am **PS-TuM1-6 Cold Plasma and Artificial Intelligence Synergistic Effects on Future Domestic Food Security: A Prospective Study***, M. Bakhshi,* Department of Cellular and Molecular Biology, Faculty of Advanced Science and Technology, Tehran Medical Sciences, Islamic Azad University, Iran (Islamic Republic of)*; F. Ostovarpour,* ***Mohammad Sadegh Abbassi Shanbehbazari,*** Laser and Plasma Research Institute (LAPRI), Shahid Beheshti University, Iran (Islamic Republic of)*; A. Bakhshi,* School of Physics, Institute for Research in Fundamental Sciences (IPM), Iran (Islamic Republic of)

Plant diseases affect the yield and appearance of plants which can be detected using machine learning. Image processing techniques and computer vision can detect the differentiated spots on leaves, stems, petals and roots. In this research, we try to suggest the artificial neural networks (ANNs) as a promising feedback of plant diseases to control atmospheric cold plasma activated water (PAW). Carefully introducing the reactive species can treat the plants and seeds which result enhanced features like the disease/stress resistance, metabolism boosting, surface modifications and growth enhancements. Induction of plant's immune system and inactivation of pathogens is possible with PAW as a green method and the amount of reactive species/treatment time can be controlled by ANNs. Thus, the severity and type of diseases can determine cold plasma parameters which leads us to an automated and smart agriculture for domestic/personal food security enhancing. Combining the PAW part, plant pot and ANNs satisfies primary needs of plant care from germination state. Furthermore, amount of nitrogen fixation in soil-based agriculture can be adjusted using a database or simultaneous monitoring of the plant. In soilless agriculture like hydroponics and aeroponics, using the assembled device has emerging applications in space colonization and saving the species.

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