Surface Engineering - Applied Research and Industrial Applications
Room Golden State Ballroom - Session GP-ThP

Surface Engineering - Applied Research and Industrial Applications (Symposium G) Poster Session

GP-ThP-1 Water and Oil Repellent Coating on Fabric Using Hollow Cathode PECVD, *R. Mbamkeu Chakounte,* Univ Appl Sci & Arts (HAWK), Göttingen, Germany*; J. Jolibois,* AGC Interpane, Germany*; O. Kappertz,* Univ Appl Sci & Arts, (HAWK), Göttingen, Germany*; **John Chambers (john.chambers@agc.com)**,* AGC Plasma Technology Solutions, USA*; H. Weis,* AGC Interpane, Germany*; H. Wiame,* AGC Plasma Technology Solutions, Belgium*; W. Viöl,* Univ Appl Sci & Arts (HAWK), Göttingen, Germany

Thin film deposition is a suitable process for textile finishing at a time when environmental protection is a global concern. Thin film technology textile treatments not only avoid the harmful chemistry and resulting hazardous waste of wet chemistry, but limit the use of chemicals, water, etc., and do not require a drying system, resulting in much lower energy consumption. Various PECVD processes have therefore been developed over the years for the textile industry to overcome wet processing's disadvantages.

Water and oil repellent finishes are amongst the most studied treatments for fabrics. With PECVD, surface modification is carried out through plasma polymerization, which produces polymers with a higher degree of cross-linkage than conventional polymers. Moreover, these plasma processes are room temperature methods, so heat-sensitive monomers can be used. Among the commercially available precursors, short perfluoroalkyls can thus be used to impart water and oil repellency to fabrics, avoiding long-chain perfluoroalkyls which endanger the environment, human and animal life through the release of PFOAs and PFOS.

Within thin film industry, hollow cathode plasma source (HC) technology is increasingly gaining attention for PECVD. The key advantages of this technology are a high deposition rate and a good uniformity over large areas. However, HC is a high-density plasma source, appropriate for the deposition of inorganic layers, typically SiO_2, but challenging for the deposition on fabrics without modifying their bulk properties or damaging their surface.

In this work, we demonstrate the successful use of HC technology to impart water and oil repellent properties on polyolefin textiles with fluorinated and silicone precursors. The effect of parameters such as power, pressure, gas composition and flow on water and oil repellency have been evaluated according to international standards, contact angle and the film composition analysed through FTIR measurements. Water contact angles greater than 150°, *i.e.* superhydrophobic surface, and oil repellency grade of 4 have been obtained.

Keywords: Low-pressure, hollow cathode, plasma polymerization, water and oil repellent

GP-ThP-2 Modification of Polymer 3d Printed Parts Through Vacuum Metallization, ***Andrew Miceli (n00928754@unf.edu)**, G. Bevill, S. Stagon,* University of North Florida, USA

Polymer three dimensionally (3D) printed parts have grown to become the most common prototypes for mechanical and functional design over the last decade. Like their classical injection molded counterparts, these polymer parts can benefit from surface metallization. For example, our group has metallized 3D printed polymer parts to increase mechanical performance, act as reflectors for telescopes, and protect the polymer from ultra-violet light damage. Unlike injection molded parts, the surfaces of 3D printed parts from the fused deposition modeling (FDM) method are naturally rough. Additionally, legacy wet-chemical metallization techniques for non-conductive polymers have fallen out of favor due to the use of caustic and toxic chemicals. In this presentation we demonstrate the metallization of poly-lactic-acid (PLA) 3D printed parts from the FDM method using magnetron sputtering. Prior to metallization, the parts surfaces are modified through low energy atmospheric plasma etching. Surface roughening is observed and characterized using scanning electron microscopy and laser scanning optical microscopy. Film adhesion is measured in accordance with ASTM D3359 and adhesion is shown to improve with the degree of plasma etching. Additionally, the electrical resistivity of the films is measured using four point probe. As an extension, smooth high-reflectivity surfaces are made to demonstrate the applicability of this method for the rapid prototyping of reflectors. Overall, it is shown that sputter deposition metallization of polymer 3D printed parts is a promising technique to improve the functionality of these rapidly prototyped parts.

GP-ThP-8 Reactive HiPIMS Deposition of AlO_x Interlayer for Pt Thermistors on SiN_x, ***Atasi Dan (atasi.dan@nist.gov)**, E. Antunes, C. Yung, N. Tomlin, M. Stephens,* Applied Physics Division, National Institute of Standards and Technology (NIST), Boulder, USA*; J. Lehman,* Applied Physics Division, National Institute of Standards and Technology (NIST), USA

Thin film thermistors with negative temperature coefficient of resistance (TCR), like Pt, are desirable for temperature-sensing applications. To achieve high sensitivity in detecting a small change in temperature, a high-quality interlayer of AlO_x is required between the SiN_x membrane and the Pt thermistor. High power impulse magnetron sputtering (HiPIMS) is known to produce high-quality thin films by generating high ionization of sputtered material which can significantly improve properties of the film over conventional sputtering techniques. In the case of reactive HiPIMS, it is important to monitor the reactive gas flow, peak current, growth rate, etc, to avoid instability in the process and control the growth of the poisoned layer on the target surface.

In this study, we investigate how target poisoning on the Al surface in the presence of oxygen can be influenced by a change in pulse length or frequency. We also show that an appropriate selection of deposition parameters can systematically provide an easier control in the reactive HiPIMS process to determine the performance of the film. The present results open the possibility of using a HiPIMS-based AlO_x interlayer in $Pt/AlO_x/SiN_x$ thermistors for achieving a high negative TCR. Additionally, we show the role of Pt target power in enhancing the TCR of $Pt/AlO_x/SiN_x$.

GP-ThP-9 Synthesis of Large Area ta-C Coating by Single-bend FCVA Source Using in-line PVD System, ***HoeKun Kim (ndkim2@naver.com)**, K. Lee, S. Lee,* Korea Aerospace University, Korea (Republic of)*; J. Kim,* University of Incheon, Korea (Republic of)

Tetrahedral amorphous carbon (ta-C) coating is a hydrogen-free carbon coating with the remarkable properties comparable with those of diamond film, such as high hardness, optical transparency and chemical inertness. Moreover, ta-C coating can be synthesized through a relatively convenient method and has a much smoother surface, making the tribological performances of ta-C coating better than those of other diamond coatings. Among the various attempts used to prepare ta-C coatings, the filtered cathodic vacuum arc (FCVA) method is a particularly suitable technique for the mass-production of industrial ta-C coatings, and the performable properties make ta-C coatings suitable for potential commercially important components in applications such as automobile accessories, optical devices, and aerospace parts. In this study, large area ta-C coating on a 300x300mm STS plate was synthesized by single-bend filtered cathodic vacuum arc (FCVA) using in-line PVD system. Source and bend filter connecting 45° bent together were used to produce carbon plasma from a graphite target with a diameter of 50mm and a purity of 99.99%. Especially, raster magnet system was designed and constructed for large area synthesis in this source. The large area ta-C coatings with 1.8µm thickness were synthesized successfully, and thickness uniformity was showed as 92.4%. Raman spectroscopy analysis showed that the ta-C coatings had high sp3/sp2 fraction over 63%, and the hardness showed high values of 48.5 GPa. In addition, the ta-C coatings with 700nm in thickness, a sp3/sp2 fraction over 74%, and about 63 GPa hardness could be synthesized with a similar uniformity. Detailed experimental results will be presented.

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