Plasma Science and Technology
Room 2009 - Session PS1-TuA

Emerging Plasma Applications

Moderator: J.B.O. Caughman, Oak Ridge National Laboratory

2:00pm **PS1-TuA1 Formation of Gas Barrier Films for Polymer Sheets with Metal Ion Source**, ***Y. Nishido**, K. Nakamura,* Chubu University, Japan

The polymer film has been widely used for various practical applications as a light and cheap material. However there is a problem of air leakage caused by penetration of gas molecules due to low dense film property. On the other hand, a surface modification has been utilized as useful technologies to add functionalities to the materials. In particular, plasma-based ion implantation and deposition (PBII&D) allows us to improve adhesion of thin films serving the functionalities with an underlying substrate. In this study, fundamental investigations were carried out for applications of a metal ion source to formation of gas barrier dense films with the surface modification technique. An 13.56 MHz inductively-coupled argon plasma was produced for a typical pressure of several tens mTorr, and sputtered copper atoms were mixed into the plasma. The ionization fraction of the copper atoms increased with the argon pressure, and reached over ~90 % for the pressure higher than ~60 mTorr. Thus such a high pressure operation enabled the plasma to act as a copper ion source. Copper films were deposited on polyimide sheets as gas barrier films. To evaluate gas barrier characteristics, the deposited films were pressurized with Helium gas in two atmospheric pressures, and transmitted gas flow rates of Helium were measured with a differentially-pumped quadrupole mass analyzer (QMA). The deposition of the copper thin films made the gas leakage of the polyimide sheets significantly suppressed, and their gas barrier property was absolutely improved with an increase in thickness of the copper films. Furthermore, high-pressure operation (>30 mTorr) was preferable to suppression of the gas leakage, suggesting that the formation of the gas barrier films with metal ions is effective for improvement of the gas barrier properties.

2:20pm **PS1-TuA2 Room Temperature Crystallization of ITO Films on Glass and PET Substrates using RF Plasma**, *M. Suzuki, Y. Shibayama, A. Kinbara, T. Watanabe,* ***H. Ohsaki,*** The University of Tokyo, Japan

Indium Tin Oxide (ITO) thin films were deposited by DC magnetron sputtering method at room temperature on soda-lime glass and polyethylene terephthalate (PET) substrates. X-ray diffraction (XRD) profiles indicate that the films have amorphous structure. The films were placed in a barrel-type discharge chamber having a pair of half cylindrical type electrodes installed in the proximity of the barrel wall and were exposed to a capacitively coupled RF(13.56MHz) discharge plasma for 10 minutes. The films were electrically floating during the plasma treatment. Although the temperature rise of the films during this treatment was less than 100°C, the films were crystallized and the XRD peaks were assigned to bixbite indium oxide peaks. The resistivity of the films decreased more than 50% after the plasma treatment. We found from the experimental results with changing the plasma treatment time that the crystallization starts at least 1 minute after the initiation of the plasma treatment and 2 minute treatment is enough to almost complete the crystallization. In order to investigate the effects of the gas component inclusions in the films on the crystallization, Quadrupole Mass Spectrometer measurements were carried out during the whole process. The effects of the carbon contamination, particularly generated from PET substrates will be discussed. Because amorphous ITO films have much smooth surface and our crystallization method does not change the surface roughness, we expect that our method is well applied to current-driven-type devices, like OLED and so on.

4:20pm **PS1-TuA8 Novel Technique for Processing Biomass by way of Atmospheric Pressure Plasma Processing**, ***C.J. Oldham**, M.R. King, J.J. Cuomo,* North Carolina State University

Cellulosic materials are found in rich quantities in nature. The cellulosic materials represent a large natural resource of significant sugars for use in alcohols and other industrial products. Research on conversion of cellulosic materials such as corn stover, maple sawdust, cotton, switch grass, and others to alcohol has been heavily researched for the last few decades. Regardless of the amount of research devoted to these processes, there are problems associated with each and none are able to be scaled into an economically feasible process. Due to recent concern over energy prices and uncertainty in the oil supply, new interest has been generated for an economical process for producing alcohol from biomass. We have discovered that atmospheric pressure plasma can be used to disrupt the structure of biomass to efficiently release sugars from their binders by plasma enhanced "soft-hydrolysis". We have termed "soft-hydrolysis" to define a process for degrading cellulosic materials where in the conditions are less severe than current hydrolysis techniques. Due to radical formation in the plasma, degradation of the protective coating on the cellulosic material allows for access to the internal structure of value, i.e. the sugars in the material. Our results are significant due to the need for an alternative to current techniques requiring large concentrations of acid, high temperatures, and expensive enzymes. Plasma enhanced "soft-hydrolysis" represents a long felt need for an economical and ecological alternative for converting biomass to usable alcohols.

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