Plasma Processing
Room Naupaka Salon 4 - Session PS-TuE2
Practical Applications of Plasma

Moderators: Mia Rose Kayaian, California State University, Fresno, **Ashley N. Keobounnam**, California State University, Fresno

7:40pm **PS-TuE2-7 VHF Plasma Enhanced Atomic Layer Deposition of SiN_x**, *Y. Ji, H. Kim,* Sungkyunkwan University (SKKU), Republic of Korea*; A. Ellingboe,* Dublin City University, Ireland*; **Geun Young Yeom**,* Sungkyunkwan University (SKKU), Republic of Korea **INVITED**

Silicon nitride (SiN_x) thin films serve as important materials for various semiconductor/display devices and extensively used as a gate spacer in logic or memory devices, thin film passivation layer, etc. For these applications of SiN_x, conformal deposition on high aspect ratio structures and good film quality are required at low processing temperatures. To satisfy the requirements of SiN_x for a broad range of applications, plasma enhanced atomic layer deposition (PEALD) methods employing capacitively coupled plasma (CCP) for high pressure operation are widely investigated for high conformality, precise thickness control, excellent repeatability based on self-limiting features of the ALD processes, and for fast cyclic processing. In this presentation, the characteristics of PEALD SiN_x films deposited at a low processing temperature of 100 ^{o}C with various precursors and N_2 plasma excited by using a very high frequency (VHF, 162 MHz) CCP and floating multi-tile electrodes are reported. The properties of PEALD SiN_x films deposited with a N_2 plasma excited by the floating multi-tile electrodes were compared with those excited by a conventional 13.56MHz capacitively coupled plasma (CCP) source. It is found that the use of VHF and floating type power electrodes instead of conventional 13.56MHz diode-type CCP for N_2 plasma improve the step coverage and quality of deposited SiN_x due to high dissociation of N_2 and low ion bombardment energy to the substrate.

8:20pm **PS-TuE2-9 Instant Inactivation of Infectious Bioaerosols by Plasma Filter Technologies***, **Seunghun Lee**,* Korea institute of materials science, Republic of Korea*; K. Baek,* korea institute of materials science, Republic of Korea*; S. Jung, J. Park, E. Byeon, D. Kim,* Korea Institute of Materials Science, Republic of Korea*; S. Ryoo,* Masan National Tuberculosis Hospital, Republic of Korea*; S. Lee,* Korea Conformity Laboratories, Republic of Korea

Management of infectious bioaerosols in indoor air has emerged as an important technology due to the COVID-19 pandemic. Bioaerosol management can be divided into physical capture and physicochemical inactivation steps. KIMS is researching technologies to inactivate physically captured aerosols with plasma application technologies.

The plasma filter generates surface plasma on the porous ceramic to oxidize the bioaerosol, and supplies reactive oxygen species including ozone to the polymer filter located at the rear for secondary oxidation. Ozone emission, an inevitable problem of atmospheric pressure low-temperature plasma technology, has been solved through a catalyst, and ozone concentration of 0.05 ppm or less can be maintained for more than 1000 hours. It was demonstrated that the SARS-CoV-2 aerosol was inactivated by more than 99% immediately after passing the plasma filter.

In this presentation, we will briefly introduce the developed technologies and report the commercialization results.

8:40pm **PS-TuE2-10 Fabrications of High-Adhesion Copper-Coated Fiber for Antibacterial and Antiviral Filter by Ion-Beam Irradiation***, **Sunghoon Jung**,* Korea Institute of Materials Science, Republic of Korea

Filters are essential products used in masks and air purifiers to prevent pathogens such as SARS-CoV-2. Membrane filters, which are assembled of fine fibers, work in a way that filters out harmful factors (droplets, dust, etc.) in the air by physically preventing them from passing through. Recently, due to issues such as the corona pandemic, there has been an increasing demand for removing harmful factors by adding the simple physical blocking of harmful particles. Various methods exist to remove harmful factors such as plasma, ultraviolet rays, and ozone. However, these methods have a disadvantage because electricity is essential, and the factors that kill the virus mentioned above are also harmful to the human body. Therefore, a means for preventing human exposure is essential, which leads to an increase in price.

Our research team attempted to develop a non-powered antibacterial and antiviral filter. For this purpose, ion-beam surface treatment and copper coating were used. Copper is a representative antibacterial and antiviral material known for a long time. However, copper may also be harmful to the human body if inhaled. If copper is formed on the filter fiber without surface treatment on the filter fiber, the copper may escape from the filter, and a person may inhale the copper. Therefore, it is essential to secure strong adhesion between copper and filter fibers. In order to coat copper with high adhesion on the filter, the research team introduced an ion-beam surface treatment technique. When copper was deposited after ion beam surface treatment, it was confirmed that copper was coated with very high adhesion to the filter fibers without damage to fibers. Furthermore, the virus removal evaluation confirmed that more than 99% of the SARS-CoV-2 was removed on copper-coated filter. This process was able to proceed with a roll-to-roll process through a linear ion beam and sputtering process, so mass productivity could also be secured.

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