The 8th International Workshop on

Plasma-based Ion Implantation and Deposition

18/9~22/9/2005
Chengdu, China
Southwest Jiaotong University

Sponsored by
Key Laboratory for Advanced Technologies of Materials, Ministry of Education, China
Tongchuang Applied Plasma Technology Center, Southwestern Institute of Nuclear Physics
Sichuan Key Laboratory of Surface Engineering of Artificial Organs, China
Institute of Biomaterials & Surface Engineering, Southwest Jiaotong University
National Key Lab for Surface Physics and Chemistry

With Support from
Natural Science Foundation of China
K.C.Wong Education Foundation, Hong Kong
Southwest Jiaotong University
The Effects of Pulse Parameters on Macro-particles Production in Pulsed Cathodic Vacuum Arc Deposition

Yawei Hu\(^a\), Liuhe Li\(^a\), Hua Dai\(^a\), Xiaoling Li\(^a\), Xun Cai\(^a\), Paul K Chu\(^b\)

\(^a\) School of Materials Science and Engineering, Shanghai Jiao Tong University, Shanghai 200030, P. R. China
\(^b\) Department of 702, School of Mechanical Engineering and Automation, Beijing University of Aeronautics and Astronautics, Beijing 100083, P. R. China

Cathodic vacuum arc deposition (VAD) has high deposition rates and good ionization ability. It has been widely used to deposit commercial hard, protective, and decorative films such as the TiN, TiCN, DLC. However, the presence of macro-particles (MP's) hinders more extensive applications in the optical and semiconductor industry.

Macro-particles originate from the plasma-solid interaction at the cathode spots. The current of cathodic arc is localized in fragments of minute, non-stationary cathode spots. Spot formation is necessary to provide sufficient power density for plasma formation, electron emission, and current between the cathode and anode. The heat produced by the high current together with ion bombardment induces melting of the cathode materials to form melted pools. The plasma pressure on the melted cathodic pool causes the appearance of macro-particles.

Many designs have been invented to separate or remove MPs from the plasma. The most extensively used method is a magnetic filter such as a straight magnetic filter, curved magnetic filter, etc. This method successfully removes MPs but also leads to inevitable plasma loss, although suitable duct bias, magnetic field and other factors can increase the plasma transmission efficiency.

Much effort has been made to investigate the effects of the processing parameters on MP production and distribution. Studies have shown that MP production is related to the cathode materials, pressure, arc current, and axial magnetic field. The MP distribution on the substrate is influenced by the distance between the substrate and cathode, the bias voltage, and so on.

The cathodic vacuum arc current source can be operated either in the DC mode or pulsed mode. The pulsed cathodic arc has been proven to have higher ionization efficiency and several other advantages over the DC counterpart. However, few researches have focused on the relationship between the MPs and the pulsed arc currents. For the pulsed cathodic arc source, the base current, the duty cycle and the pulse frequency may all have effects on the cathode spots, melting of the cathode materials and the size of the melted pool, and so can contribute to various
degrees of MP formation. In this article, the relationship between the MPSs and the pulse parameters such as pulsing frequency and duty cycle is studied. To more effectively study the problem, the pressure, the angle and distance between the substrate and cathode are kept the same. Copper is used as the cathode. Optical microscopy and scanning electron microscopy are used. By analyzing the MP quantities and distribution, the effects of the duty cycle on MP production can be described. For comparison, the results are compared to those of a DC arc source.