Large-area TiO_2 thin film deposition using an open-air hybrid CVD/plasma method

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Titanium dioxide (TiO2) is widely used material due to its photocatalytic effect with a good chemical stability [1]. For various applications of TiO2, the thin film form has been preferred in anti-reflection coatings, air and water purification, anti-bacterial coatings etc. To realize the film form of TiO2, sol-gel, atomic layer deposition, physical vapor deposition (PVD), chemical vapor deposition (CVD) or low pressure plasma-enhanced CVD have been adopted. In addition, atmospheric pressure chemical vapor deposition (AP-CVD) are successfully used to deposit TiO2 thin films on the substrate by introducing precursors although the method shows some drawbacks such as high carbon concentration in the deposited layers and requiring high substrate temperature for dense coating. On the other hand, PECVD at atmospheric pressure (AP-PECVD) was suggested as an alternative to overcome the problems in AP-CVD [2]. However, it is not clear the role of plasma in AP-PECVD depositing metal-oxide layer. Therefore, in this work, a hybrid method combining AP-CVD and plasma in open air was studied to find out the role of plasma and to enhance the film properties deposited by AP-CVD method. Based on the feasible studies in small area deposition, transparent amorphous TiO2 thin films are well deposited at low temperature by a large-area (300 mm) hybrid method combining CVD and plasma at atmospheric pressure as seen in Fig 1. The external parameters such as input power, gas composition and flow rate, substrate temperature are controlled to deposit uniform TiO2 films with low carbon concentration. The role of the atmospheric-pressure plasma in the process is investigated through comparison with coatings deposited without plasma ignition. From the deposited thin film morphology, chemical composition and scratch resistance properties, the use of Ar/O2 plasma shows to lead to dense morphologies with the lowest carbon contents and highest scratch resistance. We also found the higher substrate temperature up to 300 ºC brought about the changes in crystallinity from amorphous to anatase phase of TiO2 layer. The versatile method also enables film deposition on polymer film and shows good UV protection. This method, operating in open air shows promising results for the simple, large scale deposition of low carbon containing transparent TiO2 coatings.

References

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[2] S. Kang et al., Sci. Rep. 8 (2018) 16684

Acknowledgement

This work was supported by Korea Basic Science Institute (National research Facilities and Equipment Center) grant funded by the Ministry of Education (2021R1A6C101B383) and also supported from National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (2020R1F1A1054467).

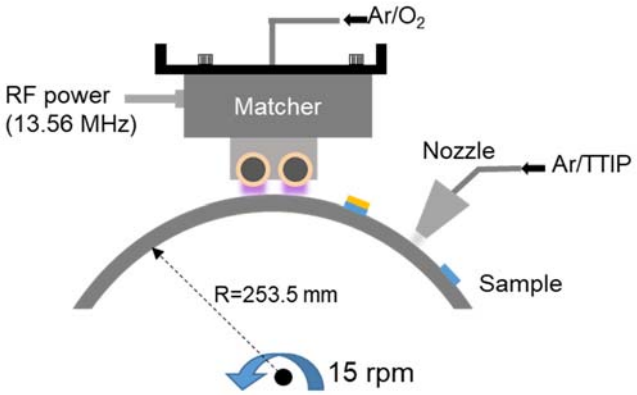

Figure 1. Large-area CVD/Plasma deposition system for TiO2 thin film fabrication