Titanium Nitride Thin-films as Plasmonic Materials with High-power Impulse Magnetron Sputtering

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1. Introduction

Low loss alternatives plasmonic materials like titanium nitride (TiN), have received significant interests in recent years [1]. TiN has low loss in the visible and NIR wavelengths and the optical properties can be adjusted that TiN is expected to serve as the alternative plasmonic material in visible and near- infrared wavelengths rather than gold and silver [2]. Reactive sputtering deposition is commonly used to deposit nitride films because the composition of the film can be controlled by varying the relative pressures of the inert and reactive gases [3]. In past decades, the development of reactive high power impulse magnetron sputtering (HiPIMS) technology has got lots of attention due to not only better performance of compound deposited films but also more smooth and denser films [4].

In this study, TiN thin films were deposited on B270 glass by HiPIMS with DC- RF co- sputtering system at 400 °C. First, the effects of power density parameter on the conductivity and optical resonant properties of the TiN thin film will be investigated. Then, the relationship between electrical and optical properties will be shown.

2. TiN thin-films fabrication and characterization

Figure 1 shows the measured dielectric function and Figure 2 shows the measured sheet resistance for HiPIMS 45/955, HiPIMS 45/45, and DC samples. When using HiPIMS technique, the denser film can be fabricated, which contains higher carrier concentration per unit volume, and the corresponding resonance wavelength will appear at a shorter wavelength. In addition, the experimental sheet resistance's relations between each sample are in good agreement with the theoretical resistivity.

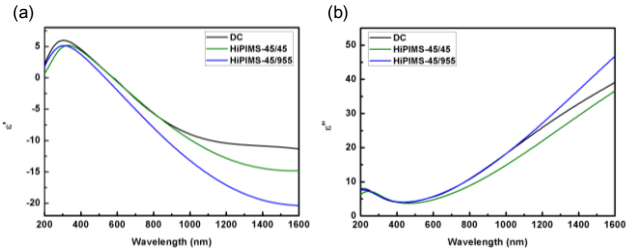

Figure 1. TiN dielectric function using various on/off ratio (a) real part and (b) imaginary part.

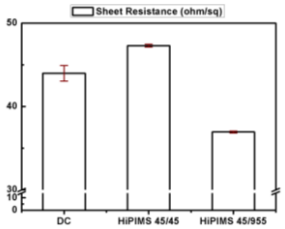

Figure 2. Electrical properties of TiN thin-films using various on/off ratio.

3. Conclusions

Compared to the HiPIMS samples, the DC sample shows poor performance, that the dielectric function over the near-infrared range exhibits obviously slowed-down slope due to the accumulated charge on the target. If the HiPIMS on/off ratio is <10% (HiPIMS 45/955), the dielectric function exhibits more metal-like behaviors, and the resistivity decreases significantly.

Acknowledgements

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