High performance solar selective absorbers constructed by multilayers

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***Abstract*—High-performance solar absorbers need to have high solar absorptivity and low infrared thermal emissivity at the same time. They are core part for architecture integratable solar thermal technologies such as solar water heaters and solar thermoelectric generators. In this work, we presented a kind of solar absorber with TiN_xO_y-based multilayers. Its solar absorbance can be as high as 97.5% and infrared thermal emissivity as low as is 4.3% with total thickness less than 300 nm. The solar absorbance can maintain above 90% for a broad incident angle to 65°.**

I. INTRODUCTION

DUE to the serious energy crisis and environmental pollution, solar energy utilizations draw huge attentions in past decades. Solar-thermal application is one of the most important and high efficiency utilizing ways, including solar water heater, concentrated solar power (CSP), solar thermoelectric generators (STEGs) and solar thermo photovoltaics (STPV). Since most of the building roofs and facades are the potential areas, it is a prospective trend for their integration with architectures. All the above solar-thermal applications rely on solar selective absorbers, which should have both high solar absorptivity and low infrared thermal emissivity at the same time. The former ensures high solar-thermal conversion rate, and the latter avoid the converted thermal energy escaping through infrared emission. The property of thermal emissivity is always conducted by a low infrared emissive metal coating such as copper on bottom. However, the absorbing layer is always thick enough to have high absorptivity while leading to high infrared emissivity.

In this work, we presented a $TiN_xO_y/TiO_2/Si_3N_4/SiO_2$ multilayered solar absorber with total thickness less than 300 nm to have high solar absorptivity and low infrared thermal emissivity simultaneously.

II. RESULTS

The multilayered solar absorber has been designed and fabricated by using multi-target reactive magnetron sputtering. In order to control the composition of TiN_xO_y thin films precisely, we provide a new approach for depositing TiN_xO_y films with TiN target in O_2 atmosphere. The $TiN_xO_y/TiO_2/Si_3N_4/SiO_2$ multilayered structure were deposited on glass or silicon substrates with a copper film thicker than 100nm to insure no transmission. The designed and experimental reflection and absorption spectra of such mutilayered absorber are shown in Fig.1. The solar absorbance is as high as 97.5%, while the emissivity is only 4.3% at 100 °C. The solar absorbance can keep above 90% for a very wide incident angle from 0° to 65° which is very good for solar utilization.

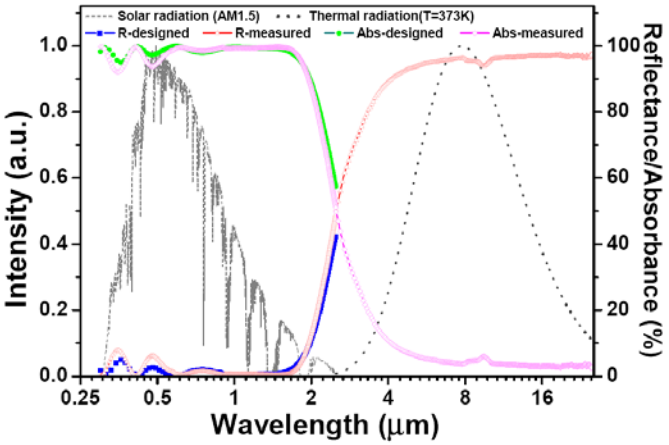

Figure 1: Designed and experimental reflection and absorption spectra for $Cu/TiN_xO_y/TiO_2/Si_3N_4/SiO_2$ mutilayered absorber, as well as normalized solar radiation (AM1.5) and thermal radiation spectra (at temperature of 373 K) for reference. The solar absorbance is 97.5% while the emissivity is only 4.3% at 100 °C for the fabricated sample.

III. SUMMARY

We presented a kind of solar absorber with TiN_xO_y-based multilayers. The fabricated absorbers with total thickness less than 300 nm have high solar absorbance and low infrared thermal emissivity of 97.5% and 4.3%, respectively. The solar absorbance can keep above 90% for incident angle from 0° to 65° which is very good for solar utilization.

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