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Optical and morphological properties of thermochromic V$_2$O$_5$ coatings

Sunil Kumar$^a$, Francis Maury$^b$, Naoufal Bahlawane$^{a,*}$

$^a$ Luxembourg Institute of Science and Technology (LIST), 5 avenue des Hauts-Fourneaux, L-4362 Esch-sur-Alzette, Luxembourg

$^b$ CIRIMAT, ENSIACET-4 allée E. Monso, 31030 Toulouse, France

ABSTRACT

We present optical and morphological characterizations performed on thermochromic V$_2$O$_5$ coatings. V$_2$O$_5$ coatings were obtained by oxidation of as-deposited VO$_x$ films. Comparisons were made among coatings oxidized at various temperatures. Photographic evidence is also shown to provide the reader a clear visual description of the color change that occurs during thermochromic process. Detailed study and analysis regarding this data can be found in Kumar et al. (2017, in press) [1,2].

Corresponding author.
E-mail address: naoufal.bahlawane@list.lu (N. Bahlawane).

Specifications Table

| Subject area          | Physics, Material science |
|-----------------------|---------------------------|
| More specific subject area | Thermochromic oxides, chemical vapor deposition |
| Type of data          | Graph, figure             |
| How data was acquired | 1) Total hemispherical reflection (THR) measurements were carried out on LAMBDA 1050 UV/Vis/NIR spectrophotometer from Perkin Elmer with a 150 mm integration sphere in the reflection configuration. |

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$^*$ Corresponding author.
E-mail address: naoufal.bahlawane@list.lu (N. Bahlawane).
2. Experimental design, materials and methods

2.1. Preparation of V₂O₅ coatings

Thin films of vanadium oxide were deposited on silicon substrates by Direct Liquid Injection (DLI) Metal Organic Chemical Vapor Deposition (MOCVD), the details of which are reported elsewhere [1,2]. Argon was used as the carrier gas at a flow rate of 50 sccm while the chamber pressure was adjusted to 10 mbar. Substrates were maintained at a constant temperature of 500 °C during the four hours of deposition.

After deposition, samples were allowed to cool till room temperature in argon atmosphere at low pressure before withdrawing from the chamber. Further handling of the samples was carried out under ambient atmosphere. Post deposition annealing was performed under ambient...
air at 300–580 °C. The annealing time was adjusted to allow a complete oxidation from VO\textsubscript{x} to V\textsubscript{2}O\textsubscript{5}. While 10 min were sufficient for oxidation at 550 °C, significantly longer times were required at lower temperatures; this can be explained by simple temperature dependent oxidation kinetics.

To isolate V\textsubscript{2}O\textsubscript{5} coatings from atmospheric gas phase interactions, Atomic layer deposition (ALD) of Al\textsubscript{2}O\textsubscript{3} was performed using the sequential introduction of Trimethylaluminium (TMA) and water. The pulse times for each reactant were adjusted to 40 ms with a 15 s purge in between each pulse. The rather large pulse and purge times were chosen to achieve complete conformal coverage over the film.

2.2. Film characterization

Total hemispherical reflection (THR) measurements were carried out on LAMBDA 1050 UV/Vis/NIR spectrophotometer from Perkin Elmer with a 150 mm integration sphere in the reflection configuration. Measurements, which correspond to the sum of specular and diffuse reflections, were
Fig. 2. Brightness versus oxidation temperature curve indicates a maximum brightness at 450 °C. It is noteworthy that sample colour is bright yellow at this oxidation temperature.

Fig. 3. Temperature dependent optical spectra of coatings obtained by oxidation at (a) 350 °C, (b) 450 °C and (c) 550 °C respectively.
performed in the visible spectral range (400–800 nm). Temperature-dependent measurements were carried out with the help of a custom made sample holder with an integrated heating element. Temperature control was achieved by a Horst HT 60 temperature controller coupled to a K-type thermocouple. The film thickness and roughness were measured using an Alpha step d-500 Profilometer from KLA-Tencor.
Fig. 5. Photographs of V$_2$O$_5$ coatings on silicon wafer, obtained by oxidation at different temperatures. Thermochromic colour change for each film is shown upon heating the films from room temperature (1st row) till 300 °C (2nd row).

Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2017.07.028.

References

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[2] Kumar S, Maury F, Bahlawane N. Tunable thermochromic properties of V$_2$O$_5$ coatings. Mater. Today Phys.; 2:1-5 (2017).