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MDPI

Surface Roughness and Fractal Analysis of TiO_2 Thin Films by DC Sputtering

Helena Vasconcelos, Telmo Eleutério, Maria Meirelles
Faculty of Sciences and Technology, University of the Azores (FCT-UAc), 9500-321 Ponta Delgada, Portugal

INTRODUCTION & AIM

Titanium dioxide (TiO_2) thin films have widespread applications in optics, electronics, and photocatalysis due to their excellent physical and chemical stability.

The **surface morphology** of these films plays a key role in determining their performance.

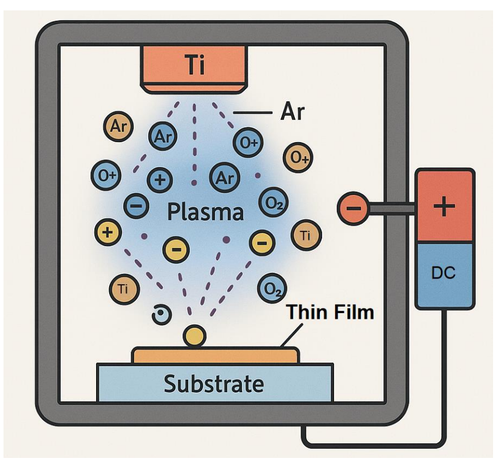
This work investigates the **surface texture** and **fractal properties** of TiO_2 thin films obtained by DC reactive sputtering under varying power and oxygen flow conditions, in order to:

- Quantify morphological features using **GLCM (Gray-Level Co-occurrence Matrix) texture descriptors**.
- Estimate **fractal dimension via box-counting** as a measure of surface complexity.
- Compare structural differences among samples.

METHOD

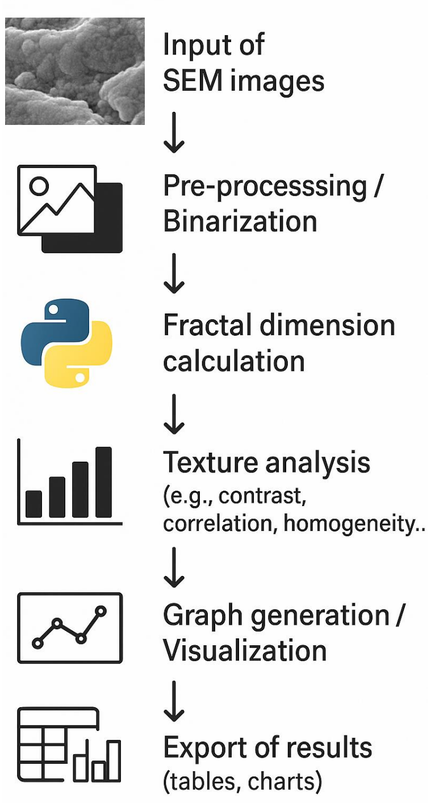
Sample Preparation

- TiO_2 films were deposited by DC reactive sputtering on suitable substrates.
- Deposition conditions varied by power and O_2 percentage:



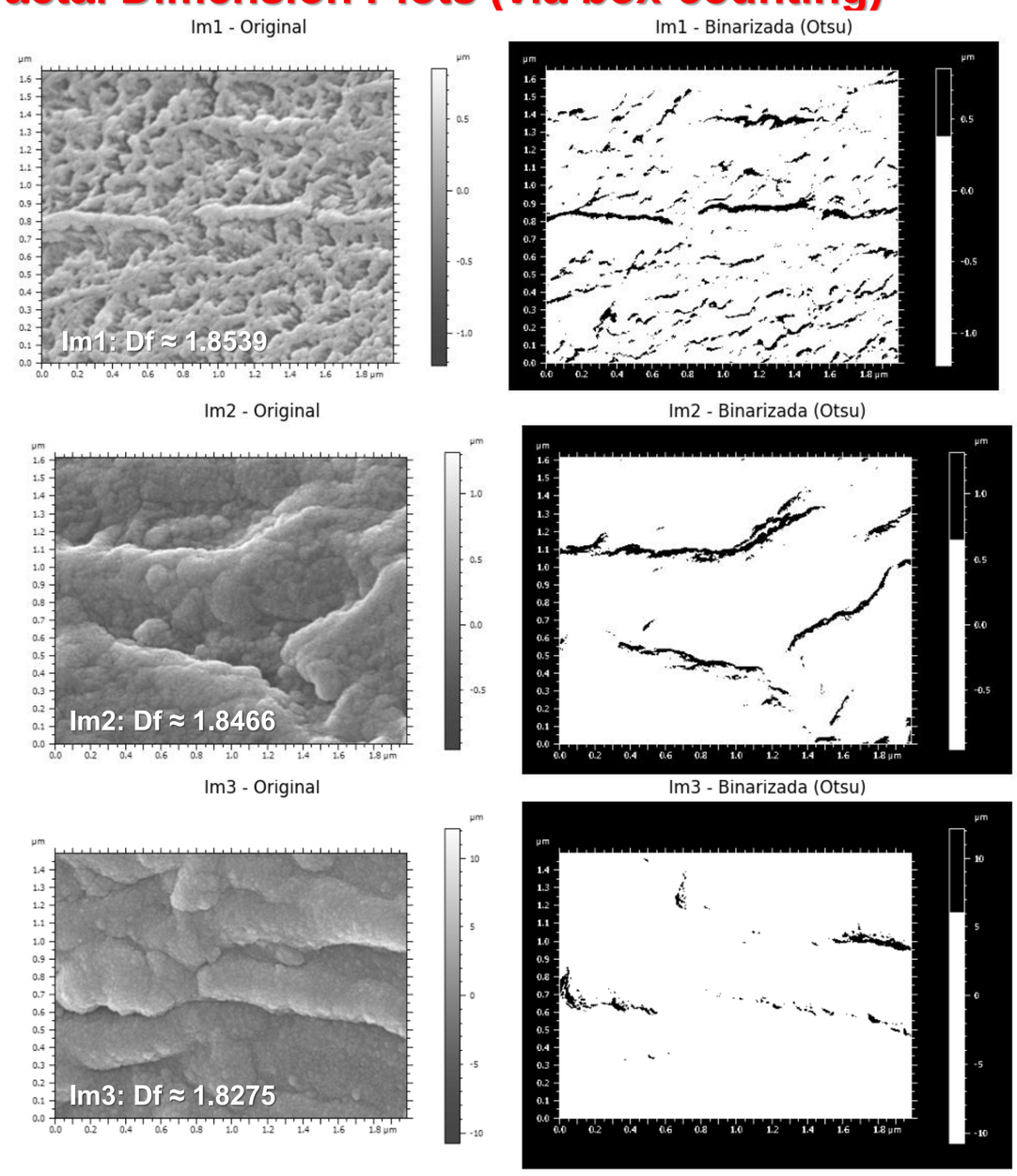
Sample	Oxygen (%)	Power (W)
Im1	50%	1000 W
Im2	75%	500 W
Im3	75%	1000 W
Im4	50%	500 W

Image Acquisition & Processing Layout



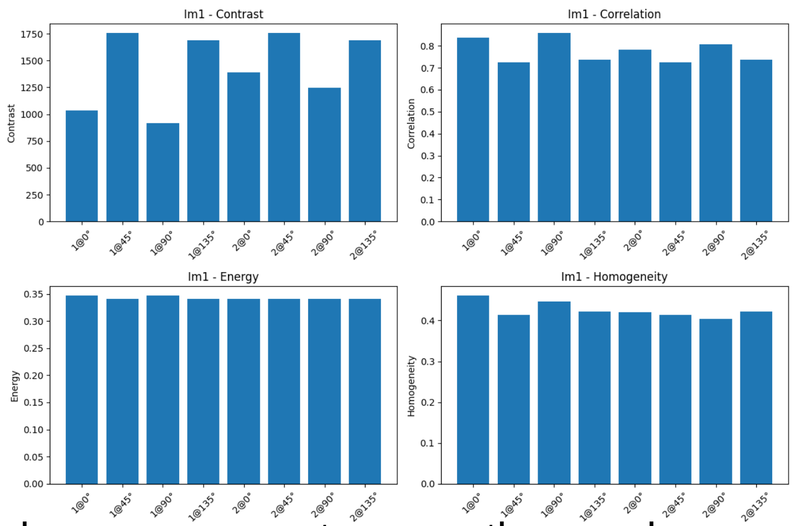
RESULTS & DISCUSSION

Fractal Dimension Plots (via box-counting)



Films deposited at higher O_2 (75%) and/or higher power (1000W) (like Im2 and Im3) tend to have greater surface complexity. The lowest complexity (Im4) comes from the film with low O_2 (50%) and low power (500W).

Texture Features (GLCM)



- Im3 is the smoothest, most uniform, and homogeneous film.
- Im1 and Im4 are rougher and less uniform.
- Increasing O_2 % and power promote smoother and more homogeneous textures consistent with increased fractal dimension observed.

CONCLUSION

Surface complexity of TiO_2 films varies with deposition conditions. Higher oxygen and power levels tend to increase roughness and heterogeneity, as shown by fractal and texture analysis.

REFERENCES

Eleutério, T., Sério, S., & Vasconcelos, H. C. (2023). Growth of Nanostructured TiO_2 Thin Films onto Lignocellulosic Fibers through Reactive DC Magnetron Sputtering: A XRD and SEM Study. *Coatings*, *13*(5), 922. https://doi.org/10.3390/coatings13050922