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Influence of RF sputtering power during RFMS on the electrochemical behavior of zirconia thin films in a Hanks solution

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INTRODUCTION & AIM

Zirconia (ZrO_2) thin films have become very attractive to the coating industry thanks to its remarkable properties. ZrO_2 can exist in the monoclinic, tetragonal or cubic phases depending on the temperature. These interesting properties has led to numerous efforts to deposit ZrO_2 films by various techniques, including chemical vapor deposition (CVD)**[1]**, sol-gel techniques **[2]**… and sputtering **[3]**. Magnetron sputtering offers good control over the deposition rate, and film composition **[3, 4]**. The aim of this study was to prepare ZrO_2 thin films using RF magnetron sputtering method at different sputtering power and to systematically investigate how the sputtering power affects their microstructure, surface morphology, hydrophobicity and electrochemical behavior in a physiological environment .

METHOD

A pure zirconium target was sputtered in Ar-O_2 gas mixture. The sputtering power was varied in order to investigate its influence on the film's properties.

Target	Pure Zirconium (99.99%)
Target-Substrate distance	30 mm
Base Pressure	1.0×10^{-6} Torr
Sputtering gas	20 sccm of Ar
Reactive gas fraction	30% of O_2
Sputtering Power	**100- 250- 400 W**
Deposition time	60 min
Substrate Bias	-100 V

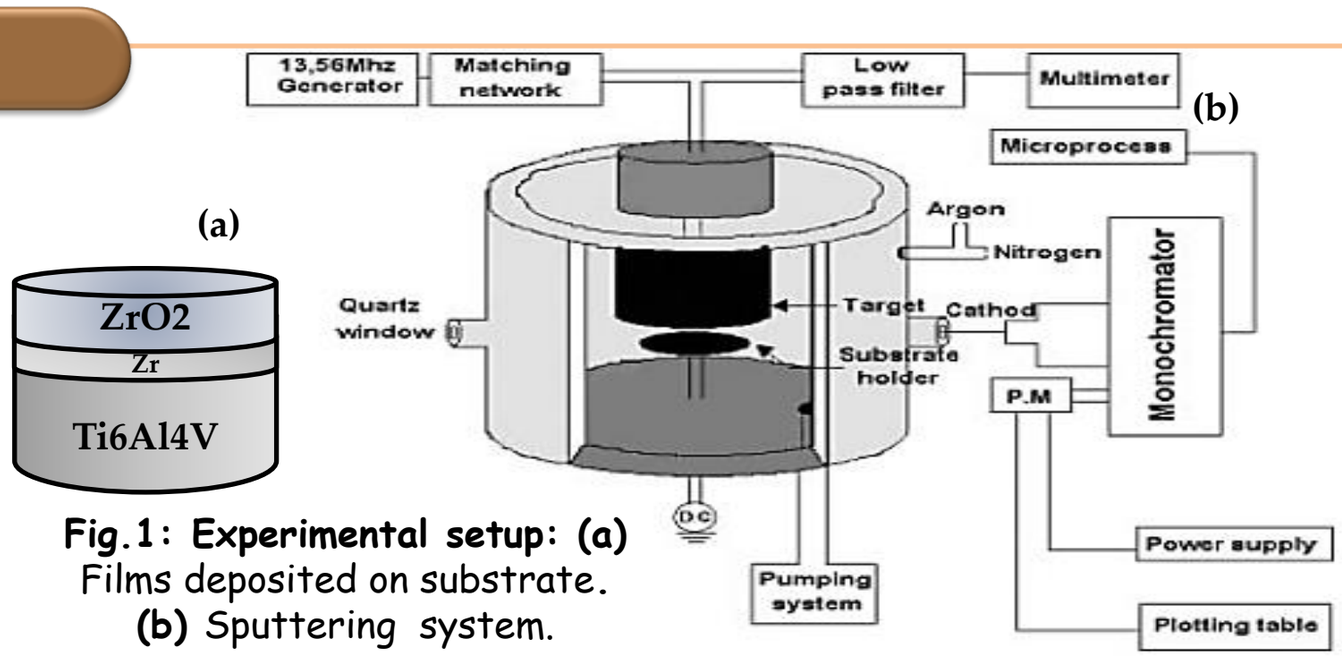


Fig.1: Experimental setup: (a) Films deposited on substrate. **(b)** Sputtering system.

RESULTS & DISCUSSION

Morphology :

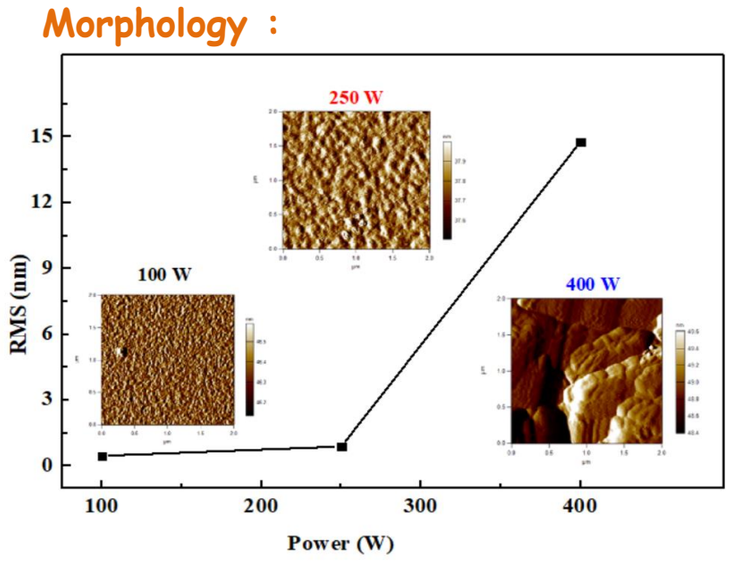


Fig.2: Roughness and AFM images of the surface morphology of deposited ZrO_2

Hydrophobicity :

Fig.4 : Contact angle and images of the water droplets on ZrO_2 deposited films

Structure:

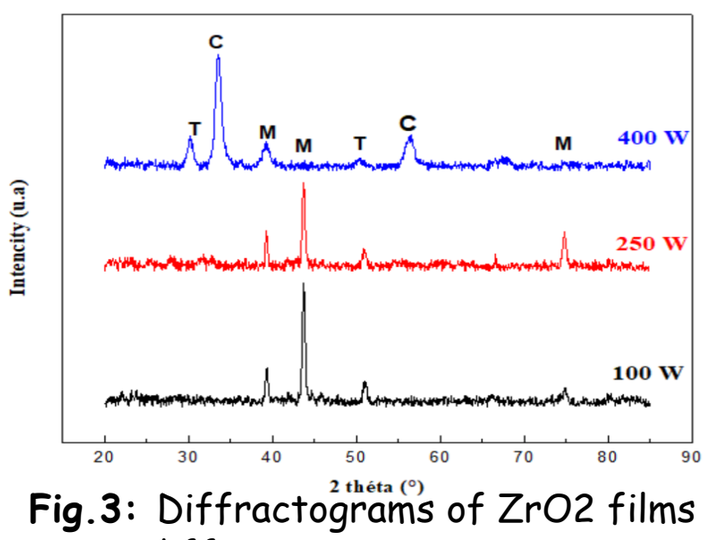
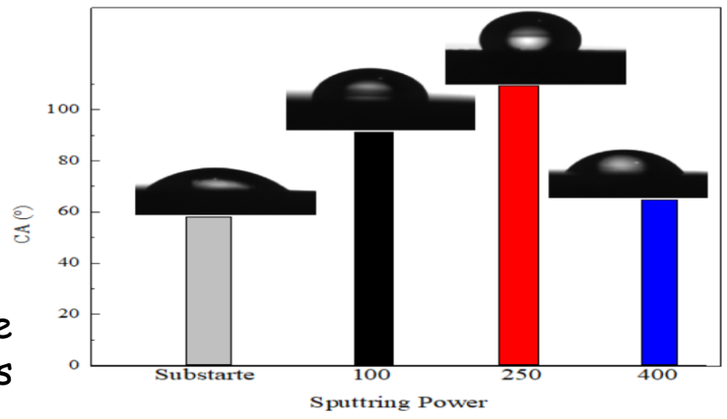
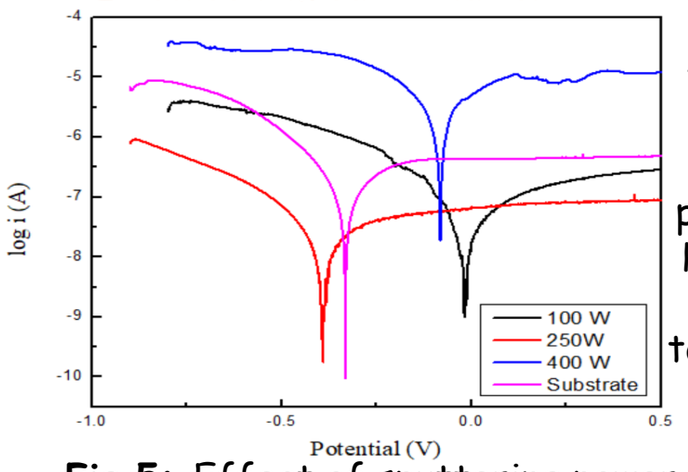


Fig.3: Diffractograms of ZrO2 films at different sputtering power



Electrochemical behavior



The electrochemical behavior of the films was assessed trough potentiodynamic polarization tests in Hank's solution at a temperature close to that of the human body.

Fig.5: Effect of sputtering power on the polarization curves of coated and uncoated substrate in Hanks' solution

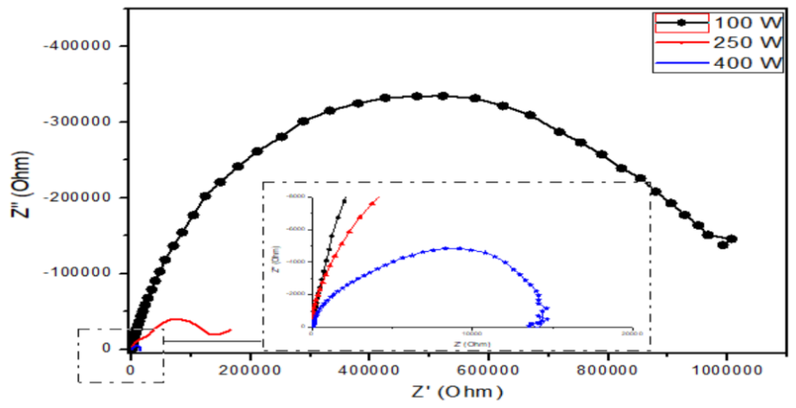


Fig.6: the Nyquist plot for ZrO_2 deposited films.

CONCLUSION

The Zirconia coatings were successfully prepared using RF magnetron sputtering. The AFM results showed that Higher sputtering power led to a significance increase in the surface roughness, and induced a crystalline phase transition from monoclinic to cubic structure. the contact angle measurement showed that a sputtering power of 250 W produced the most hydrophobic films. the electrochemical results showed that the Zirconia films exhibited a protective anti-corrosive performance. In conclusion, the results demonstrate that the sputtering power is a key deposing parameter for tailoring different properties of zirconia thin films, confirming their potential as a protective coating for biomedical metals.

REFERENCES

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