Preparing the bioactive surface of TiZrTi system by femtosecond laser pre-patterning of Si substrate

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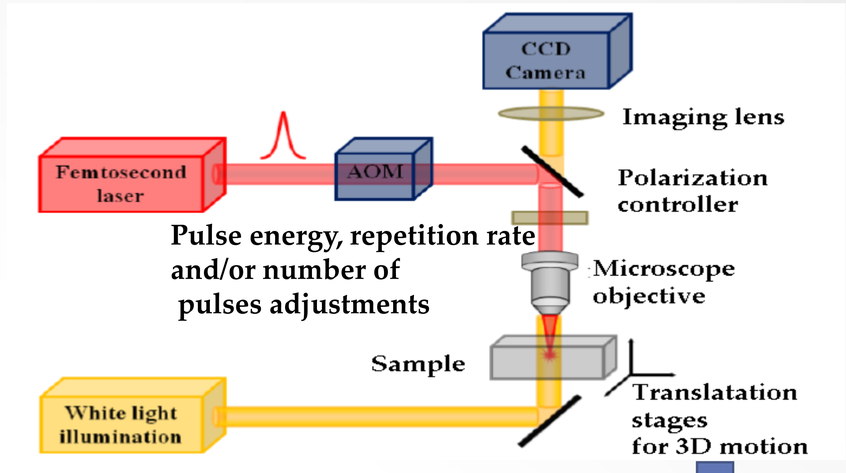
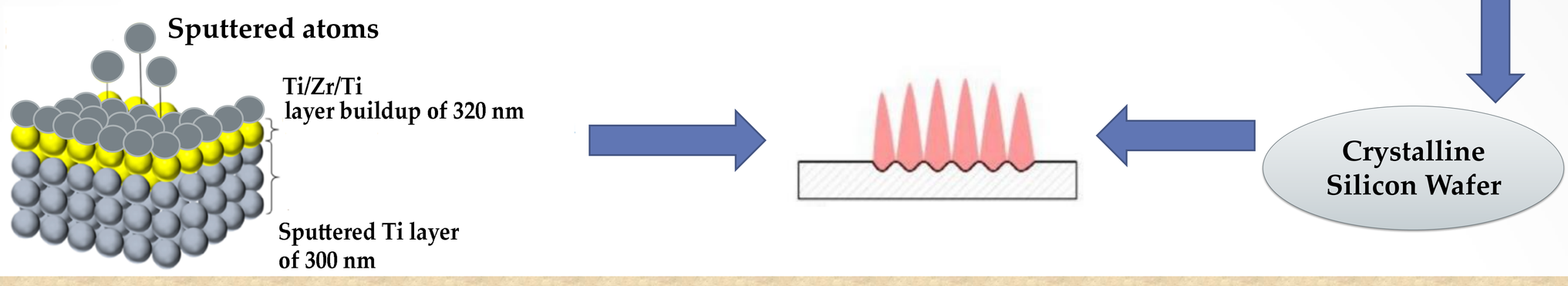
~ Abstract ~

The experimental study of the dynamic femtosecond laser substrate pre-patterning for the TiZrTi thin film system is reported. The design of surface pattering with the micrometre features in the form of spikes is investigated in order to improve the arrayed surface structures for biomedical applications. Femtosecond laser pulses were used to acquire black silicon surfaces decorated with conical structures (spikes) on crystalline silicon surfaces under 0.65 bar of SF_6 environmental atmosphere. After irradiation, the silicon surface exhibits high aspect ratio spikes, which have conical shapes of about 2 μm height, 40° angle opening, $13x10^6$ cm^{-2} density that remains approximately uniform across the processed area. Ion sputtering was used to create unique composite thin films on pre-patterned Si substrates that consist of of Ti thin film with Zr subsurface layer at 10 nm below of surface.. The thickness of the deposited composite in Ti/Zr/Ti form was 320 nm. The composition, surface morphology and wetting properties were analyzed by scanning electron microscopy (SEM-EDS) and wettability measurements.

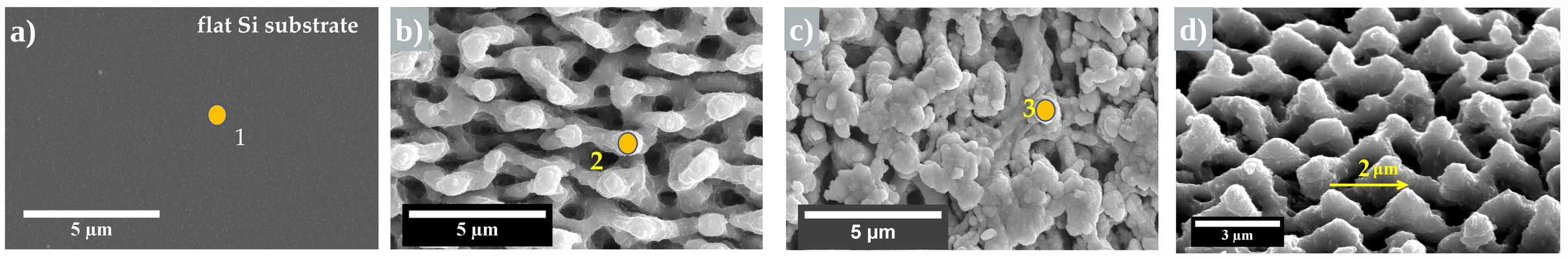
~ Experimental ~





~ Results and discussion ~

SEM, EDX and wetting measurements



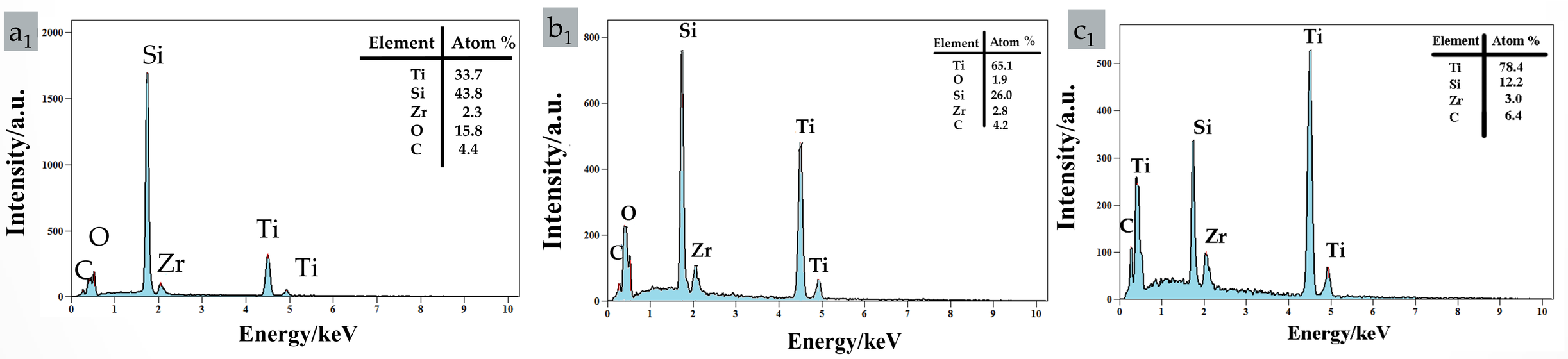


Fig.1.FE-SEM micrographs with EDX spectrums of Si substrate prepared by fs laser irradiation on: a) flat Si, b) bare Si spikes and c) spikes coated with TiZrTi thin film by the ion sputtering process.. Micrograph d) represents the side view of pre-pattern Si substrate.

Conclusion

The creation of pre-patterning on a Si substrate coated with Ti/Zr/Ti thin film was presented. It can be concluded that the Ti/Zr/Ti thin film followed the laser pre-patterned substrate surface where its thickness did not uniform due to the non-homogeneous distribution of Ti and Zr components observed by EDS mapping. The results of wetting measurements suggest that ultrafast laser processing can be used to introduce the hydrophobicity of the surface with groove geometries that promote increased cell adhesion.

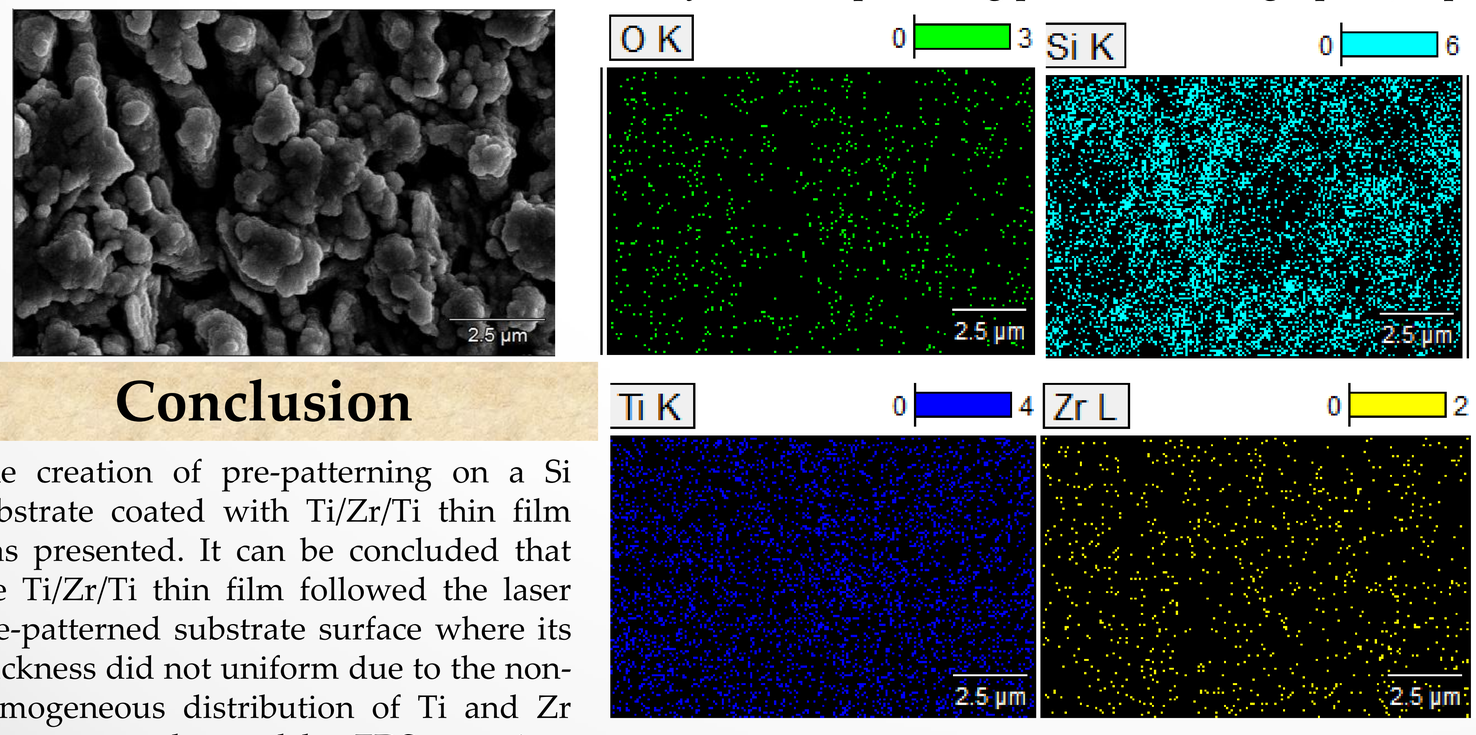


Fig. 2. EDX mapping of the laser-modified surface for pre-pattern Si substrate coated with TiZrTi.

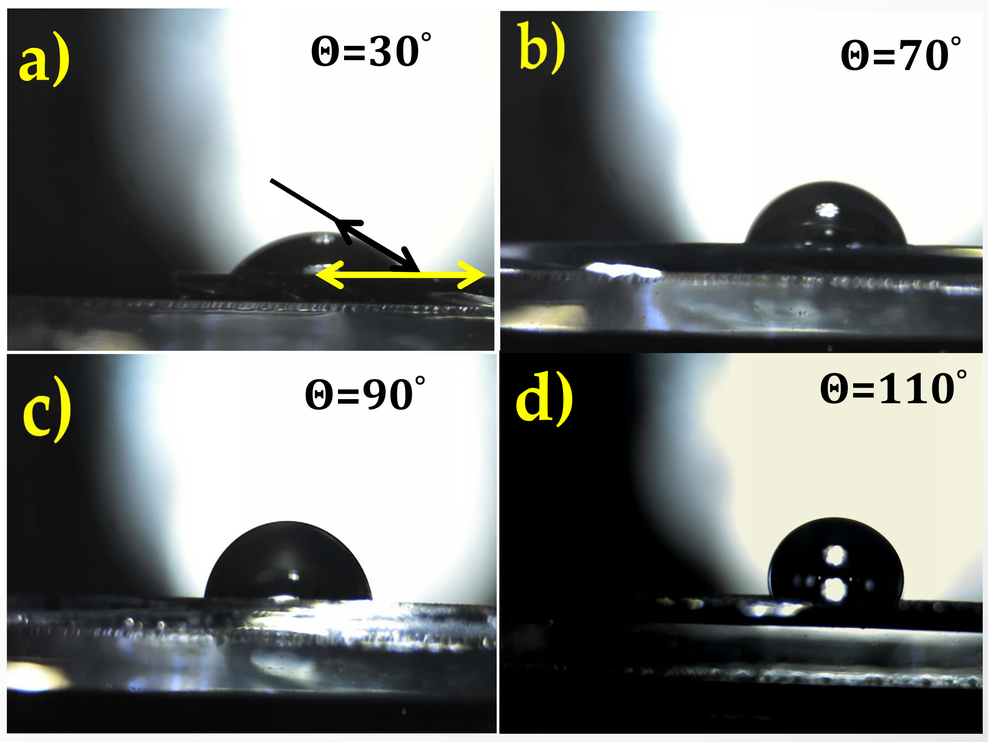


Fig. 3. Static behavior of 5 μl liquid drops of deionized water on the surfaces: a) flat Si; b) pre-pattern Si; c) TiZrTi coated on flat Si; and d) TiZrTi coated on pre-pattern Si.

~ Acknowledgment ~

This research was funded by The Ministry of Science, Technological Development and Innovation of the Republic of Serbia under the registration number: 451-03-47/2023-01/200017. This project has received funding from the EU-H2020 research and innovation program under grant agreement N 101007417 having benefitted from the access provided by the Foundation for Research and Technology Hellas (FORTH) access provider (Institute of Electronic