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INFLUENCE OF ELEMENTAL DISTRIBUTION IN ZIRCONIUM SAMPLES ON MECHANICAL STRENGTH

Izabela Wilkos, Mateusz Wirwicki

UTP University of Science and Technology in Bydgoszcz, Poland

70 YEARS OF UTP
UNIVERSITY OF SCIENCE AND TECHNOLOGY
in Bydgoszcz

Department of
Mechanical Engineering

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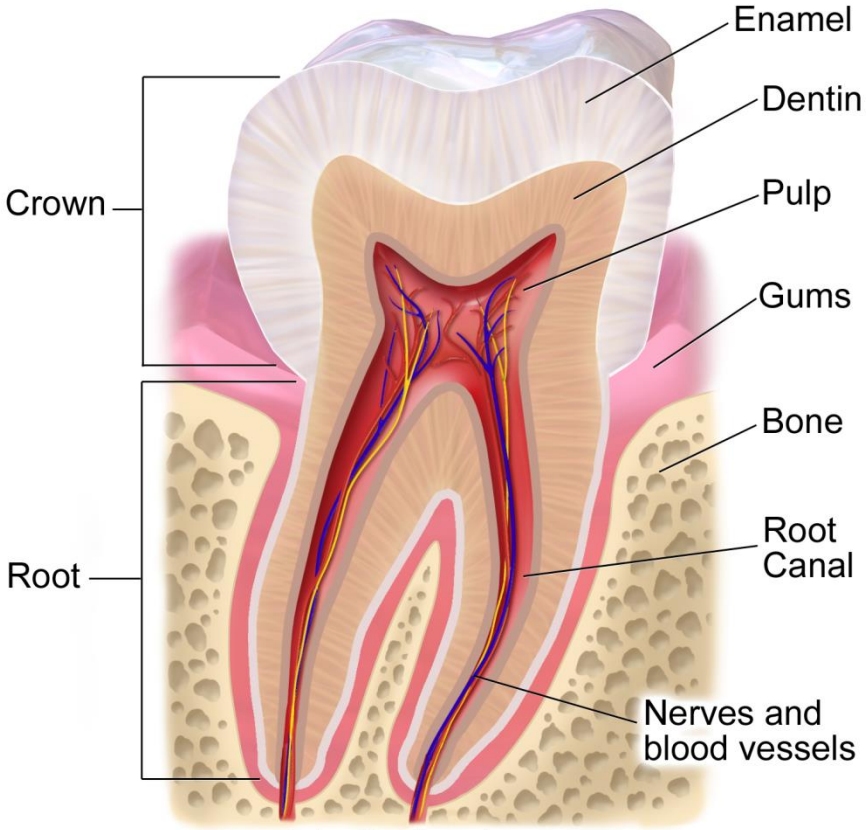
Presentation Plan

- Work genesis
- Material characteristic
- Specimen geometry
- Testing machine
- Results

Work genesis



Tooth Anatomy

With the latest materials patient has the feeling that the tooth filled with acts like a natural tooth. There are opportunities to rebuild the tooth root where there is no possibility of sticking of the crown.

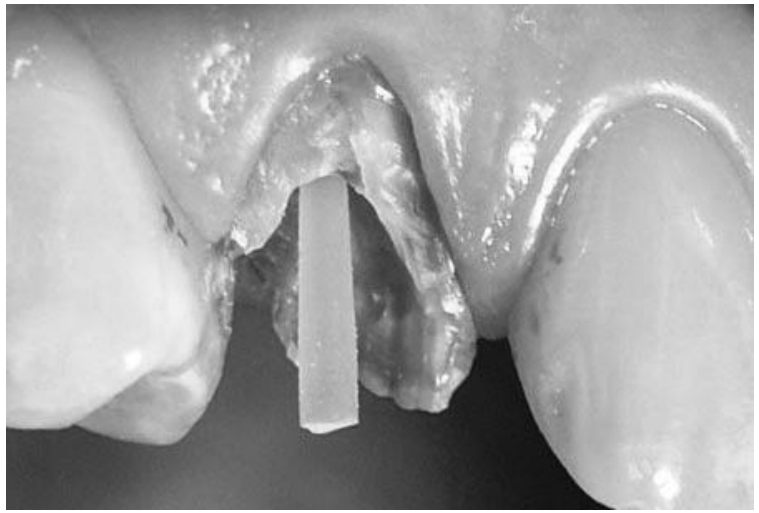
Each of the treatments described above has its problems in the reconstruction of functional and aesthetic. There are also problems associated with the assessment of the strength and durability of these treatments, including in relation to the adhesive connection with the all-ceramic crown . This problem also concerns a design of the connection between the crown of the tooth, the absence of evaluation criteria constructional features of the combination. There is a huge interest and topicality of the issue.

Work genesis

Prosthetic crown

The crown used in prosthetics is a type of overlay to the rear on the crown of the tooth , the contribution crown - root or implant. The crown is necessary when :

- Tooth decay is destroyed to a large extent.
- Tooth crumbled and there is no wall on which the seal can be fixed (common to the root canal when the tooth is dead) .
- With Stains enamel susceptible to other dental treatments .
- With the correction of the tooth Crowns are used in implantology as the last phase of the reconstruction of the tooth.



Material characteristics

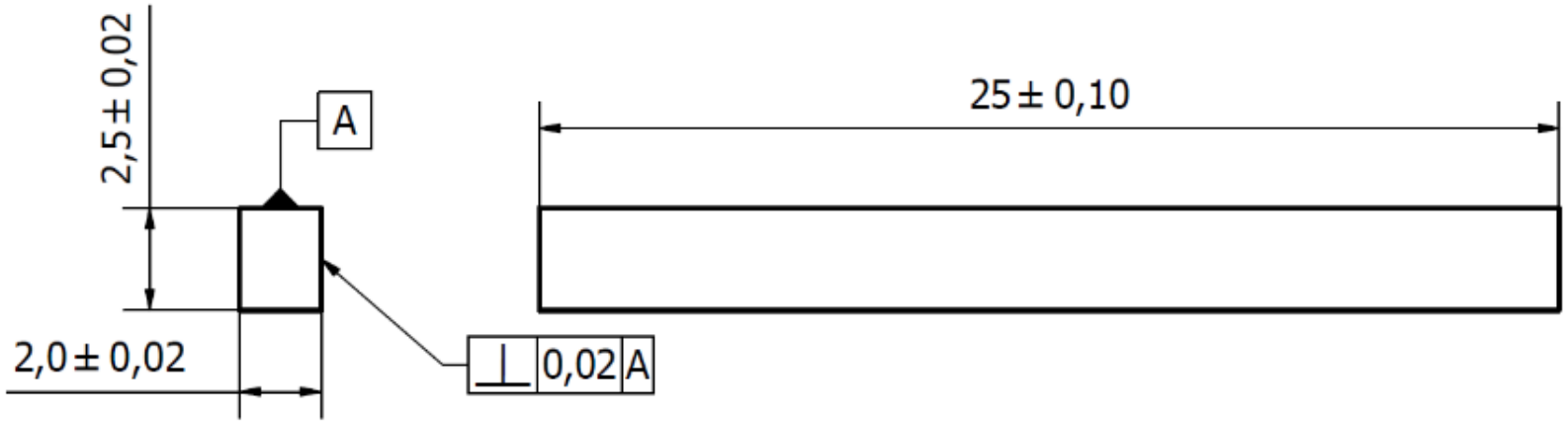
The test material is zirconium dioxide used: for the manufacture of structural parts of machines , in dentistry .

The test material was Dentsply Sirona Cercon . The advantage of this material is : -high strength, -Excellent and natural aesthetics, - biocompatibility, - no metal content in its structure.

Ceramik	Flexural strength [MPa]	Hardness Vickers [GPa]	Density (g/cm^3)
Strengthened Mica	71 -107	3,72 – 4,46	2,56
Strengthened Leucite	109 – 154	6,57 – 6,67	2,50
Trioxide Aluminum	601 – 687	15	2,47
Zirconium Dioxide	840 - 1200	12,17 – 13,70	5,56 – 6,1

Specimen geometry

The study used a material having the trade name Lava zirconium which is used in the manufacture of crowns and bridges in the CAD / CAM technology. The material was processed with a circular saw (IZOMET 5000) and a Mazak Vertical Center Smart 430A milling machine. Ceramic materials used in dentistry are characterized by significant shrinkage during the curing - sintering process. According to the material manufacturer, the technological shrinkage is 20%. This process consisted of firing in a special furnace at 1410°C for 8 hours.



Testing machine

Instron 8874

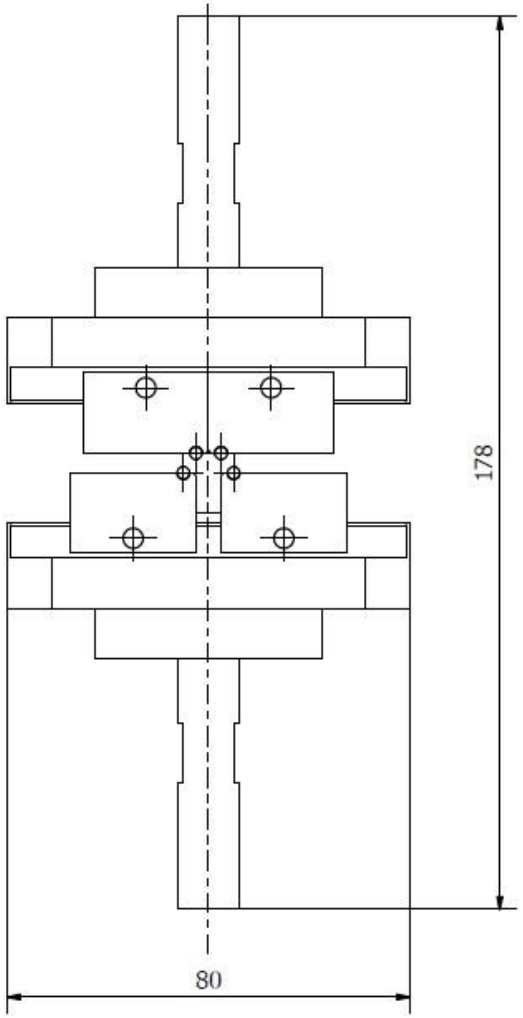
The standard testing machine Instron 8874 For testing three-point bending strength test was used for shear force gauge parameter : ± 5 kN and an axial load

Testing handle

Handle for three-point bending

PN-EN 843-1:2008: Advanced technical ceramics - Mechanical properties of monolithic ceramics at room temperature - Part 1: Determination of flexural strength

The test was carried out at the battery speed of 0.5 mm / min to destroy the sample, and the frequency of recording the test results was 5 Hz.



Scanning Electron Microscope using XRF

Jeol JSM-IT500

The device allows to enlarge the sample from 5x to 300,000x at a voltage of 300V to 30kV.
It works in two modes of vacuum: high and low.
The size of the worktable: 125mm x 100mm x 80mm.
Maximum photo resolution 5120x3840**.**

Results

Results of monotonic three-point bending

Material	Medium bending strength [MPa]	Standard deviation [MPa]	Relative standard deviation [%]
Cercon	802.18	186.33	23.22

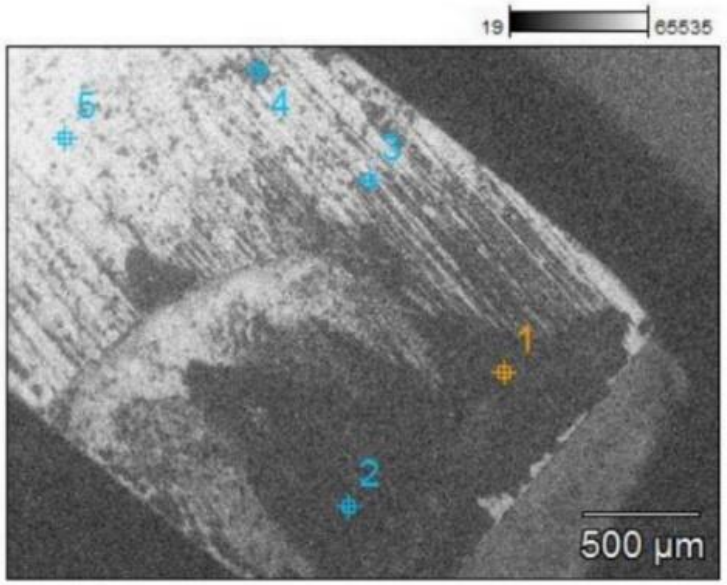
Results of Weibull distribution analysis

Material	N	σ_0 [MPa]	R^2	m
Cercon	30	888.68	0.9754	7.3

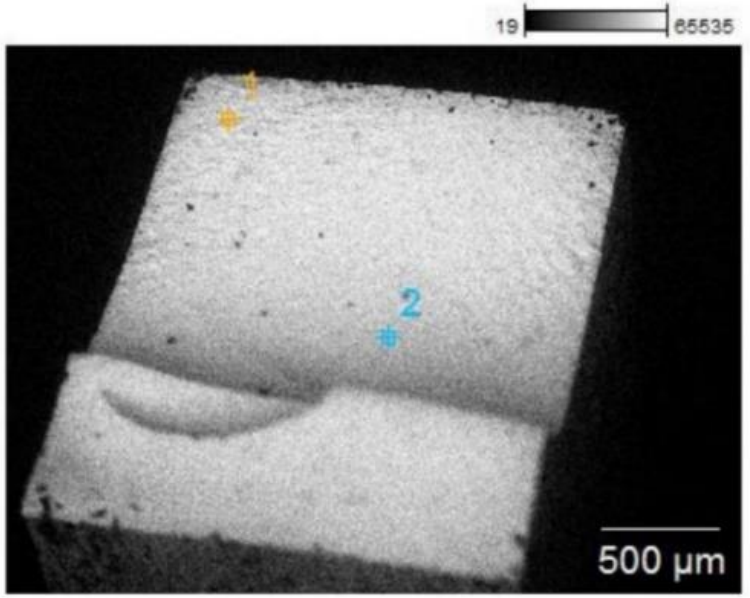
Results

Scanning microscopy, which was used to study zirconia samples, showed the relationship between the elemental composition of the surface layer and the interior of the sample.

a)



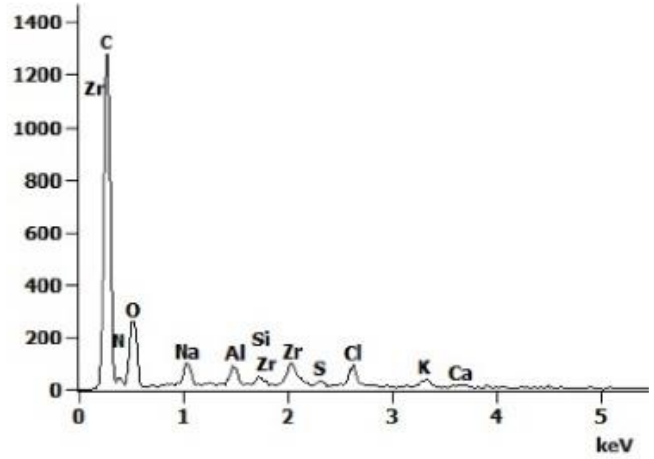
b)



On each of them several measurements were made, of which 2 characteristic were selected and compared. The composition of the outer surface of the sample showed a much richer element content as opposed to the interior of the ceramic sample. In both studied cases, the elements included zirconium, carbon and aluminum in the form of oxides.

Results

a)



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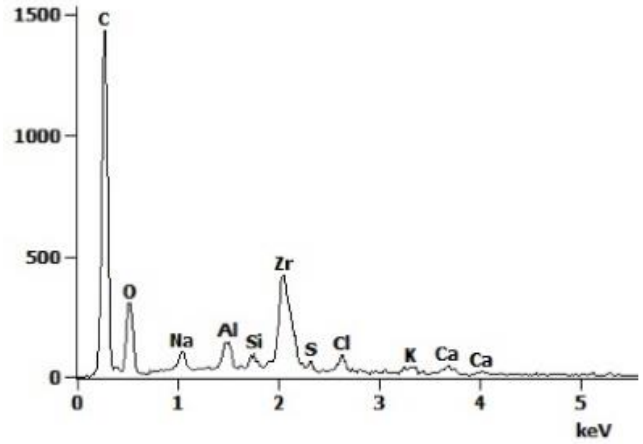

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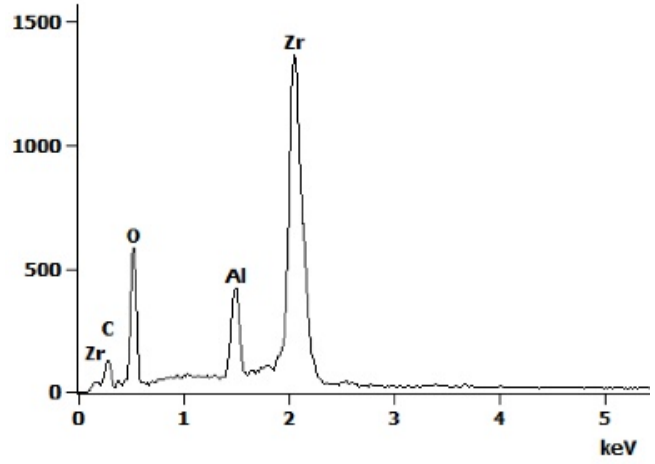

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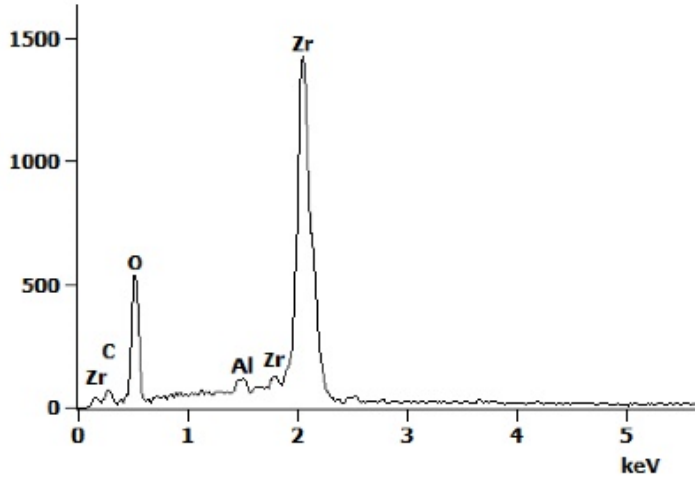

Conclusion

The operation process of preparing samples is closely related to the quality of zirconium products. Their quality determines the elemental composition of the material, especially the oxidation processes of the elements in the sintering process and their decomposition after sintering. The obtained results indicate a large impact of aluminum content on the mechanical strength of the material. Oxides of other metals depositing on the surface cause weakening of the material towards the external surface with an increase in strength inside the tested sample due to the presence of aluminum and zirconium. From the obtained mechanical and physical-chemical results it can be concluded that the mechanical strength of zirconium dioxide is strictly dependent on its composition and composition of inclusions in mass. This indicates the possibility of developing the topic in further scientific work.

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THANK YOU FOR YOUR ATENTION

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