THE IMPLEMENTATION OF A NOVEL PROCESS FOR THE PREPARATION OF COLORED ZIRCONIA BLOCKS FOR DENTAL PROSTHETICS

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INTRODUCTION
Common methods of preparation of colored zirconia substructures in dental prosthetics consist in the addition of pigments to the batch composition of ceramic material or in staining by impregnating biscuit sintered constructions by colored solutions. Opinions of dental prosthetists as well as previous research have shown that staining by impregnating does not provide sufficient uniformity of color. Therefore an alternative method of preparing a wide range of homogeneously colored zirconia blocks was sought: it was considered that coloring ready to press zirconia powders can lead to the fulfillment of established requirements.

The aim of the work described in the paper was to develop and implement an innovative system of staining zirconia powders as well as to prepare colored zirconia blocks of A1, A2, A3, A3.5 shades of Vita scale.

EXPERIMENTAL METHODS
Ready to press Y-TZP zirconia powders (CH-21) and the coloring liquid in the form of aqueous solutions with different concentrations of Fe³⁺ and Cr³⁺ were used for the study. Staining process was carried out in a rotary unit, and the coloring liquid that watered the powders during the process of mixing, was sprayed through a special nozzle. A number of liquids were prepared with different concentrations of coloring ions (Fe³⁺, Cr³⁺). Colored powders were used for static forming of test samples (Fig. 1) as well as CAD/CAM zirconia blocks that were fired at the temperature of 1500°C.

In order to evaluate the color of sintered samples the visual method (comparison with the color of the Vita scale) and determination of the values of color parameters (spectrophotometer) were applied. The impact of consecutive stages of staining (humidification, mixing, drying) on agglomeration and destruction of granules was assessed by measuring the size distribution using laser diffraction method and by observing its morphology using stereoscopic microscope.

Quality of sintered zirconia material was evaluated on the basis of apparent density tests by hydrostatic weighing method and strength measurements by three-point bending test.

The study aimed not only to confirm the possibility of effective dying zirconia powders by coloring liquids, but was also a step towards the implementation of this technology into the production of colored zirconia blocks. For this purpose, a series of model blocks, were made of colored zirconia powder and sent them to the prosthetic company - Robocam. Using CNC machine (milling machine Robomill S), a series of model substructures in the form of a three-point bridgework were cut from the discs.

RESULTS AND DISCUSSION
Apparent density tests showed that when the content of the pigment increases the value of the apparent density lowers from 6.10 g/cm³ for not colored material and A1 shade to 6.07 g/cm³ for A3.5 shade (Fig. 2).

The results of size distribution analysis for starting powder and for selected samples of colored ones indicate that the average size of the granules is higher for colored powders. This may prove that the coloring process results in a slight agglomeration (clumping) of granules, especially the finest silt fraction (Fig. 3). The presence of agglomerates of granules in colored powders is also confirmed by observations of the granules’ morphology in stereomicroscope (Fig. 4).

Coloring the powders causes a reduction in the bending strength of sintered zirconia materials (Fig. 5).

CONCLUSION
Both the ability of the material to machining and the color uniformity after firing as well as other material properties were positively rated by manufacturers. Now the Robocam company as a producer of zirconia blocks offers the colored ones, which are very popular among the dental laboratories for manufacturing fixed dental restorations using CAD/CAM techniques.