Poster

PREPARATION AND CHARACTERIZATION OF A NANOSTRUCTURED DENTAL COMPOSITE

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In modern dentistry, the direct techniques of odonto-therapy restorations, based on amelo-dentinal adhesion, have an important place and they represent a large part of the usual medical practice. The requests and the expectations of the patients are aiming to final results with a very good aesthetic aspect, in biomechanical, bio - functional and bio - physiologic optimal conditions, for the hard dental structures and the surrounded tissues. On the other side, the materials and the techniques based on adhesion allowed to realize indeed a therapeutic boarding non-invasive, and this represent the future in dentistry [1, 2].

The current dental composite, including the most modern, are nevertheless operational limited because of the certain characteristics inherent of the structure and the dependent physico-chemical properties of the inorganic part (seeds of filling) and of the organic part (the polymerized resin matrix) [3].

The present paper describes the preparation through sol-gel methods and aims to characterize ceramic nanoparticles used as filling inorganic materials for dental composites of esthetic restorations.

The sol-gel synthesis was carried out using the Stober method [4, 5]. The nanometric powder of silica was obtained starting from TEOS ($Si(OC_2H_5)_4$). That was mixed with the ethanol, the hydrolysis and condensation reactions taking place in the presence of water and ammonia.
Nanometric powder of zirconia/silica composite was also obtained. In this case, the composite was prepared using precursors of the oxide components, as: $ZrCl_4$ and TEOS ($Si(OC_2H_5)_4$). The precursors were mixed in ethanol, the gelation ocuring in the presence of 1,2 – epoxy-propan.

The powder of silica, named "S", was treated at temperatures between 1000 and 1200^0C for 2 hours, while the composite powder, named "ZS", was treated at temperatures between 700 and 1200^0C for 2 hours.

The powders "S" and "ZS", were characterized in what it concerns mineralogical composition (using an X-ray difractometer *SCHIMADZU XRD 6000),* granulometric distribution (using a laser granulometer *FRITSCH PARTICLE SIZER ANALYSETTE 22*) and the microstructure (SEM – using a scanning electronic microscope *EDAX - HITACHI S2600N* and TEM).

X-rays diffraction showed that the crystalline compounds formed are silica in his polymorphic form trydimite (figure 1), for the "S" powder, and tetragonal zirconia, for the "ZS" powder (figure 2).

The granulometric distribution showed that we have obtained powders with the following specific surfaces: for "S" the specific surface is 3,63 m^2/cc and for "ZS" the specific surface is 4,08 m^2/cc.

The scanning electronic microscopy showed that the powders "S" and "ZS" have a very fine structure, with dimensions of particles smaller than 0,5 micrometers (figure 3).

Electronic transmission microscopy showed that the powder "S" is consisting of particles in spherical form of 200-300nm in diameter, but also of smaller particles, in plate form, with an acicular aspect. The powder "ZS" have the crystals well defined, with spherical form, smooth surfaces and nanometric dimensions that vary between 3 and 5 nm (figure 4).

Taking account the results obtained, we appreciate that powders "S" and "ZS" have a real potential to be used in dental applications, but it is necessary to make more experiments in order to be able to control the dimension of particles and conglomerates.

References:

[1] Blunck U., Marktübersicht Adhesivsysteme. Zahn. Prax., **8, 1 – 2 (Jan.–Feb.)** (2005), 14-37.

[2] Mount G.J., Beyond G.V. Black, J.F., Vanherle G.: Adhesive Technology for Restorative Dentistry. **Quintessence Publishing Co. Ltd., London** (2005) 47-62.

[3] Roberson T.M., Heymann H.O., Ritter A.V., Roberson T.M., Heymann H.O., Swift Jr. E.J.: STURDEVANT'S Art and Science of Operative Dentistry. **4th ed., Mosby Inc., St. Louis** (2002) 473-481.

[4] Moszner M., Klapdohr S., Nanotechnology for dental composite, **Int. J. o Nanotechnology Vol., Nos. 1/2** (2004) 130-156.

[5] Clapsaddle B.J., Sprehn D.W., Gash A.E., Satcher J.H., Simpson R.L., A versatile sol-gel synthesis route to metal-silicon mixed oxide nanocomposites that contain metal oxides as the major phase, **UCRL-JRNL-201444** (2003) 1-27.

Figures:

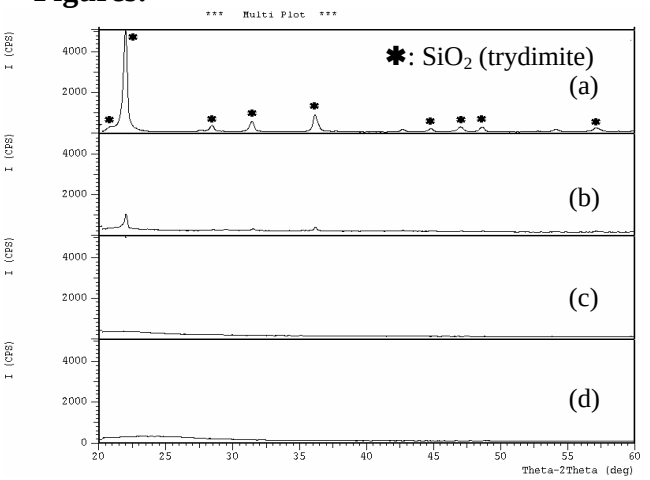

Figure 1. The spectrum of X-ray diffraction obtained on "S" powder, for various thermal treatments
(a) 1200^{0}C/2h; (b) 1100^{0}C/2h;
(c) 1000^{0}C/2h; (d) as synthetized

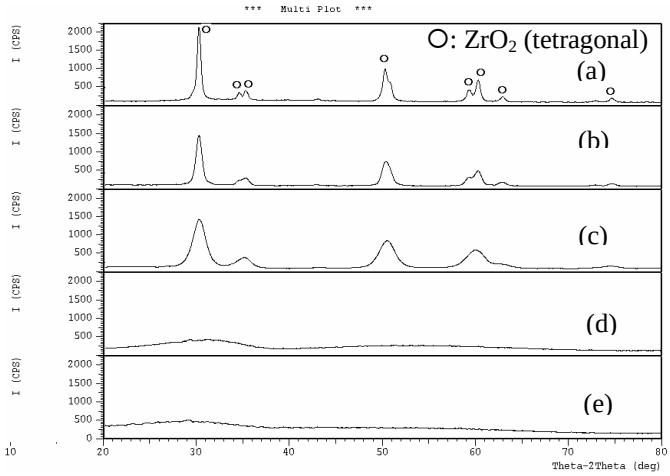

Figure 2. The spectrum of X-ray diffraction obtained on "ZS" powder, for various thermal treatments
(a) 1200^{0}C/2h; (b) 1100^{0}C/2h;
(c) 1000^{0}C/2h; (d) 700^{0}C/2h; (e) as synthetized

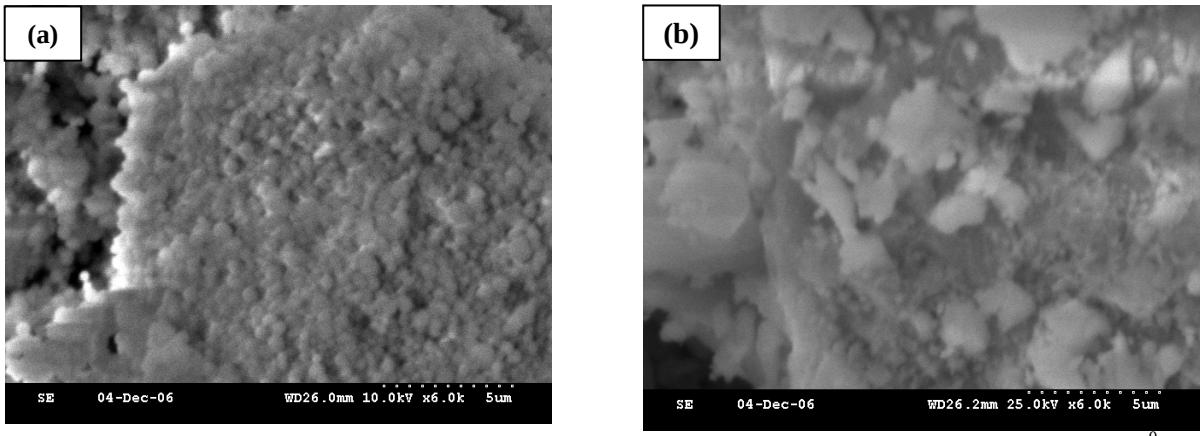

Figure 3. Scanning electron microscopy images of powder "S" (a) and "ZS" (b) thermal treated at 1000^{0}C/2h

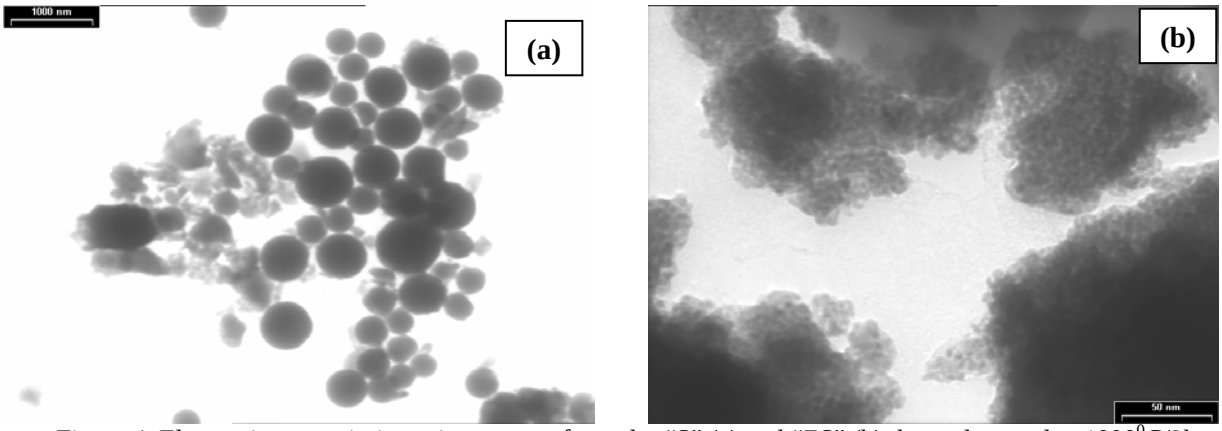

Figure 4. Electronic transmission microscopy of powder "S" (a) and "ZS" (b) thermal treated at 1000^{0}C/2h