SEM, TEM, STEM and AFM microscopy of the human tooth enamel crystallites

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< Human tooth enamel consists of 94 wt% of inorganic material and 6 wt% of organic material and water. The inorganic material is related to crystallites of hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$), but with traces of Mg, Na, Cl, among others [1]. The enamel crystallites are nanometric in size: in average of 50 nm width, 50 nm height and between 100 to 150 nm length [1]. There is a conflicting evidence whether the shape of the crystals is parallelepiped or hexagonal prisms [2, 3]. Therefore, direct observation of the enamel crystals is necessary to elucidate their shape. Another point to solve is the morphology of the enamel crystal surfaces: some authors argue that crystals have flat surfaces, others that they are roughened due to the organic material that surrounds them.

Therefore, the enamel crystallites were observed, besides by atomic force microscopy AFM in the tapping mode in air, by scanning electron microscopy (SEM), transmission electron microscopy (TEM) in the mode of bright, dark field and high resolution (HRTEM) images, scanning transmission electron microscopy (STEM) in the annular dark field (STEM-ADF) and bright field (STEM-BF) modes. In this work, we present the results obtained with each of these techniques.

The SEM images nor the STEM and the TEM images indicate the morphology of the enamel crystal surface. This is done with AFM images. AFM shows a new characteristic of the crystals of human dental enamel: that their crystals are not flat but rough, possibly residues of organic material. Figure 1 shows HAADF-STEM, BF-STEM and AFM images of human tooth crystallites.

References

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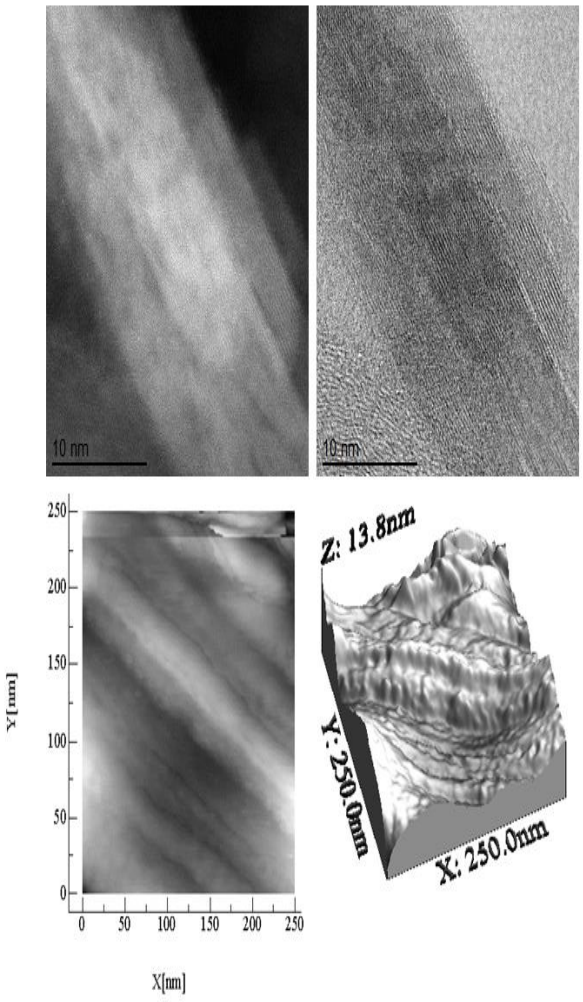

Figure. HAADF-STEM, BF-STEM and AFM images of human tooth crystallites.