Investigation of human tooth enamel down to the atomic scale

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Human dental enamel, the hardest tissue in the body, plays a vital role in protecting teeth from wear as a result of daily grinding and chewing as well as from chemical attack. It consists of a mineral phase, mainly in the form of highly oriented ribbon-like nanowires of carbonated hydroxyapatite (HAP). It is well established that enamel mechanical strength and fatigue resistance is derived from its hierarchical structure, which consists of periodically-arranged bundles of HAP nanowires. Although recent research has improved our understanding of the HAP crystallization process that leads to this structure, the relationship between microstructure and decay is still not well understood.

The investigation of such structures in human dental enamel requires a wide analysis spectrum from the macroscopic scale down to the atomic scale. Laser-assisted atom probe tomography (APT) was recently used to reveal nano-structures in apatites and rodent tooth enamel, including Mg-rich amorphous calcium phosphate (ACP) nanolayers between the HAP nanowires that make up the enamel, and Mg-rich elongated precipitates and pockets of organic material among the HAP nanowires (1). An earlier study also revealed Fe alongside of Mg in rodents teeth pigmented enamel ACP nanolayers (2), which was found to render the enamel harder and more resistant to acid attacks. Inspired by this work, we analysed the diffusion of iron in human tooth enamel using an iron-rich solution treatment and its impact on the enamel resistance to acid attack by correlating results from APT and various other microscopy techniques.

References:

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