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Working Mechanism of Tooth Whitening Based on Hydroxyapatite Suspended in a P11-4 Peptide Matrix

 # 0838

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Introduction

Two alternative explanations in the literature how hydroxyapatite (HAP) contributes to the whitening of teeth:

- **Niwa at al. (2001): remineralization processes make surfaces of teeth smoother and glossier = Glossy Reflection**
- **Roveri et al. (2009): a HAP surface layer increases the diffuse reflection of light, which results in a measurable increase in lightness = Diffuce Reflection**

Objective

To evaluate how hydroxyapatite (HAP) suspended in a self-assembling peptide matrix contributes to tooth whitening.

Methods

HAP suspended in a self-assembling P11-4 peptide matrix (Credentis, Windisch, CH) was applied to 10 teeth.

1. **Group 1: Self-Assembling Peptide P11-4 (Curodont Repair, prepared according to manufacturers instructions), was dissolved in water and 50% HAP-suspension was added 1:1. Final concentrations: P11-5 = 5mg/ml; HAP 12.5wt%**
2. **Group 2: An aqueous suspension of 0.02mg/ml P11-4 and 0.5wt% HAP was prepared and applied.**

The suspensions were applied to the surface in a thin homogenous layer. After 5 min loose remnants were washed away.

The bidirectional reflectance was measured with an angular-resolved goniometer before and after the application. The tooth surface was illuminated with a laser at 650 nm (angle of incidence 0° or 30°). The light scattered from the tooth (surface and subsurface scattering) was detected with a calibrated HDR CCD sensor (angle of reflectance plus/minus 90°, 5° steps).

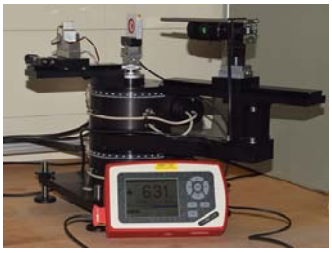


Fig. 1: Laser beam intensity monitoring (0,5 µW)

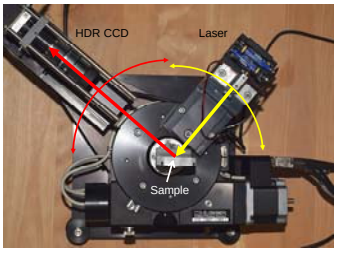


Fig. 2: Top view of the goniometer. The laser source and the ccd detector rotate computer controlled around the sample.

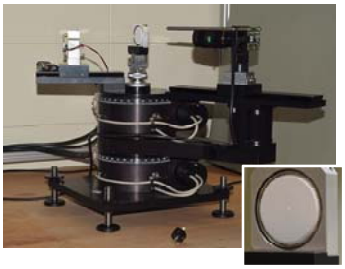


Fig. 3: Spectralon reference.

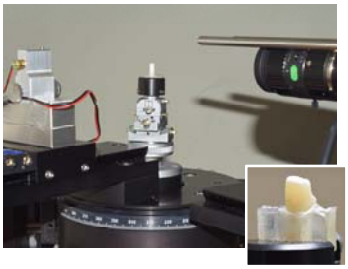
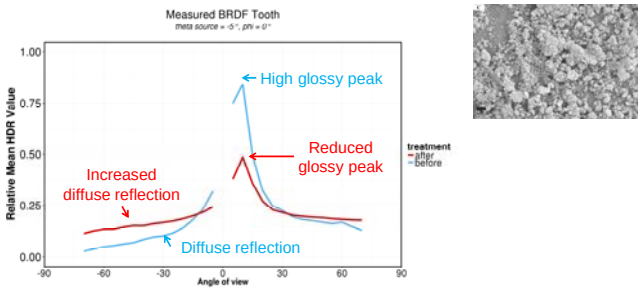


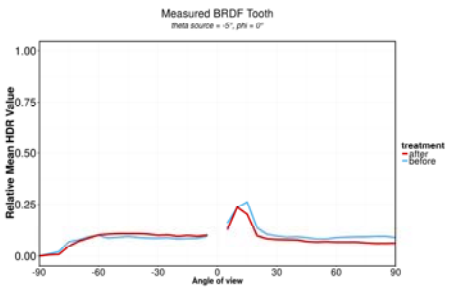
Fig. 4: Tooth sample.

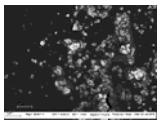
Results

Group 1: High concentration SAP Matrix and HAP



Group 2: Low concentration SAP Matrix and HAP





Group 1:
- The specular reflection was 0.8 relative to the maximum of Spectralon before the application of the HAP/P11-4 mixture. This value dropped to a mean value of 0.5 after the application.
- The diffuse reflection increased after the application between 0 and 0.15 relative mean HDR units. This difference was significant for angles greater then +/- 30 degrees (t-test for each angle).

Group 2:
- No effect of the treatment could be observed. We conclude that the concentration of HAP was too low.

The angle resolved goniometric optical scattering instrument is an elegant method to characterized naturals tooth surfaces.

Conclusion

The initial whitening effect of HAP-particles dispersed in a matrix of self-assembling peptides can be explained with an increased diffuse reflection of light.

References

Niwa M, Sato T, Li W, Aoki H, Daisaku T. Polishing and whitening properties of toothpaste containing hydroxyapatite. J Mater Sci Mater Med 2001; 12: 277-281

Roveri N, Battistella E, Bianchi Cl, Foltran I, Foresti E, Iafisco M, Lelli M, Naldoni A, Palazzo B, Rimondini L. Surface Enamel Remineralization: Biomimetic Apatite Nanocrystals and Fluoride Ions Different Effects. J Nanomater 2009; (special issue)