Modern approach of dental materials interface investigations

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Introduction. The dental materials interfaces could be investigated by invasive methods (such as mechanical testing or microscophyc investigations) and noninvasive methods (including optical coherence tomography - OCT) [1, 2]. The applications of OCT on dental interfaces were developped on odontotheraphy [3], prosthodontics [3], implantology [3], endodontics [4] and orthodontics [5]. The main advantages of this method rely on the possibility of quick and complex noninvasive diagnostic of the dental interfaces, and the results can be validated by other investigation methods. The topic of this conference is focused on OCT evaluation of various interfaces associated with direct restorative materials.

Materials and Methods. Two *en-face* OCT systems have been used. Both use similar pigtailed super-luminescent diodes (SLD) emitting at 1300 nm and having spectral bandwidths of 65 nm which determine an OCT longitudinal resolution of around 17.3 microm in tissue. The first OCT system performs OCT only, in both C-scan and B-scan regimes, allowing 1 cm lateral image size. The second system, equipped with a confocal channel at 970 nm, uses a high optics interface allowing 1 mm image size. The configuration of the second system, uses two single mode directional couplers. For each sample there was an OCT investigation, a combine OCT / Confocal investigation and OCT / Confocal / Fluorescence investigation after the fluorescence agent was added to the sample. The OCT scanning at 18 or 8 degree (zoom) in air lead to stacks of 98 slices, with 33 microns between the slices. The OCT/Confocal scanning lead to 3D reconstructions that allow localizing and evaluating the magnitude of the defects. After that the fluorescence agent (fluorescein) was applied on the teeth / resin interfaces and than another OCT scan was performed.

Results. Marginal adaptation at the interfaces and gaps inside the composite resin materials were identified by means of optical coherence tomography. The cavities were filled with a comercially available adhesive layer and then a second layer (improved adhesive layer) was applied. The second adhesive layer was easier to be observed, due to the increased scattering. The sandwich structure created in this way can give information on the behavior of the adhesive layer in interaction with the dental structure. The samples were investigated with OCT in order to characterize the two adhesive layers. For the first OCT set of investigations, the interface between the dental structure and the adhesive layers was hard to evaluate in C scan mode. A narrow line with a variable width was observed between the tooth structure and the second layer of improved adhesive. This line extends long the entire interface length and but due to its optical characteristics the presence of gaps or voids cannot be assessed. In B scan mode the interface can be much easier to be characterized. The first layer of adhesive (unimproved) has a different thickness: from very thin layer to 2 – 3 times the thickness of the second adhesive. An important observation is that the material defects such as aeric inclusions in the improved scattering adhesive can be differentiated from the normal adhesive layer (fig. 1)

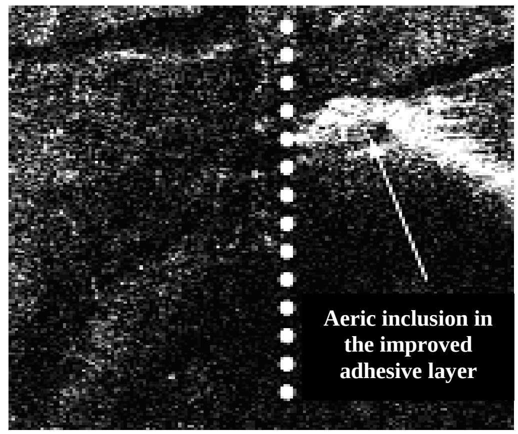

Fig. 1. The left part with normal adhesive and the right part with the better scattering adhesive. Note a small aeric inclusion in the improved layer of adhesive.

Conclusion. OCT has numerous advantages which recomands its use in the oral cavity in comparison with conventional dental imaging. OCT can achieve the best depth resolution of all known methods (basically 1 micron if the source exhibits a sufficiently wide spectrum) and is safe. It is important to use an optimized adhesive in order to identify the material defects incorporated in it.

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