Plasma Treatment for Dental Restoration Application

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Polymethacrylate-based dental composites have received widespread clinical acceptance as alternative restorative materials to dental amalgam amid concern regarding the potential health risks associated with mercury release. As supported by results from multiple clinical and laboratory studies, however, the current dental composite restorations suffer from much reduced longevity mainly due to interfacial failures of dental adhesives to the surrounding tooth structures, which cause microleakage, sensitivity, recurrent caries, and composite restoration failure [1,2]. **A**dequate dentin/adhesive bonding requires dispersion of the adhesive throughout the dentin surface and micromechanical interlocking of adhesive with collagen fibrils in decalcified dentin [3].

The objective of this study is to investigate the non-thermal atmospheric plasma treatment effects on dentin surfaces for oral bacterial disinfection, dentin surface modification, adhesive wettability improvement, and composite restoration bonding enhancement. Oral bacteria of *Streptococcus mutans (S. mutans)* and *Lactobacillus acidophilus (L. acidophilus)* with an initial bacterial population density between 1.0×10^8 and 5.0×10^8 cfu/ml were seeded on various media, which including porous filter papers, smooth glass slides, hydroxyapatite disks, and dentin slices from extracted human teeth. The survivability of these oral bacteria with plasma exposure was examined and evaluated. The plasma exposure time for a 99.9999% cell reduction was less than 15 seconds for *S. mutans* and within 5 minutes for *L. acidophilus*. Scanning electron microscopy (SEM) was used to examine the cell structural changes upon plasma treatment. It was found that the plasma treatment induced a significant alteration in cell size and morphology when compared with the untreated controls.

To evaluate the dentin/composite interfacial bonding, extracted unerupted human third molars were used by removing the crowns and etching the exposed dentin surfaces with 35% phosphoric acid gel. The teeth thus prepared were sectioned into micro-bars as the specimens for tensile test. Student Newman Keuls (SNK) tests showed that the bonding strength of the composite restoration to peripheral dentin was significantly increased (by 64%) after 30 s plasma treatment of the dentin surfaces. Fourier transform infrared (FTIR) spectra of plasma treated dentin surfaces showed two major structural changes of the demineralized dentin after plasma treatments as compared with the untreated controls. First, a new shoulder peak around 1,760 cm^{-1} associated with carbonyl stretch was found. Second, an amide II shift of ~10 cm^{-1} was observed (1,543 cm^{-1} before to 1,533 cm^{-1} after), which might indicate the secondary structural changes of dentin collagen after plasma treatment. These chemical changes of the collagen fibrils may allow more interactions with the adhesive resins applied subsequently. The findings from this study indicated that non-thermal atmospheric plasma technology is very promising for dental clinical applications.

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