Plasma Treatment of Dentin Surface for Enhanced Adhesive Bonding

A.C. Ritts[1,2], Jennifer Claybrooks[1,2], Q.S. Yu[1,*], H. Li[1], X. Yao[3], C.Q. Xu[3], L. Hong[3], Y. Wang[3,*] M. Chen[4]
[1] Center for Surface Science and Plasma Technology, Department of Mechanical and Aerospace Engineering, University of Missouri, Columbia, MO 65211, USA
[2] Department of Chemical Engineering, University of Missouri, Columbia, MO 65211, USA
[3], School of Dentistry, University of Missouri–Kansas City, 650 E. 25th Street, Kansas City, MO 64108, USA
[4] Nanova Inc., Columbia, MO 65203

Statement of Purpose: **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.[1] One major difficulty in evenly dispersing the adhesive through the collagen fibrils in dentin is the variability of collagen in different types of dentin. Occlusal dentin tends to give lower bond strengths than proximal or buccal dentin due to greater regional variability in dentin wetting.[2] The purpose of this study is to investigate the plasma treatment effects with various reactive gases on dentin surfaces to modify dentin surface chemistry, improve dental adhesive wettability, and thus enhance the interfacial bonding strength of dental composite restorations. In this study, addition of oxygen, nitrogen, and methane reactive gases into an atmospheric argon plasma brush were investigated in term of surface treatment effects on dentin surface and thus the adhesive bonding strength.

Methods: An atmospheric cold plasma brush (ACPB), a non-thermal gas plasma source, was utilized to treat and prepare dentin surfaces for dental adhesive and dental composite application. Extracted unerupted human third molars were used for this investigation. The occlusal one-third of the crown was sectioned by means of a water-cooled low speed diamond saw (Buehler, Lake Bluff, IL). The exposed dentin surfaces were polished with 600 grit SiC sand papers under water and then etched using 36% phosphoric acid. Dentin surfaces were treated by Ar plasma with reaction gas addition for 0, 30, and 60s. Adper Single Bond Plus dental adhesive (3M ESPE) and Filtek Z250 composite (3M ESPE) were applied and light cured as directed. Dentin/composite bars (8-10 mm ×1 mm × 1 mm) were cut from the prepared teeth for tensile testing and interface characterization. Peripheral and inner dentin were tested separately due to variations in strength. Fracture surfaces were separated into dentin, composite, and adhesive/mixed.

Results: Our tensile test data shown in Figure 1 indicates that increasing plasma treatment time on the dentin surface increased the tensile strength of the dentin/adhesive interface of peripheral dentin. It was found that numerous plasma treated samples failed in locations other than the dentin/adhesive interface, while most of the control samples failed at the interface. Figure 1 also shows that plasma treated inner dentin is indistinguishable with its untreated counterpart; however the sample size is very small in inner dentin making conjecture difficult. Oxygen and nitrogen gas additions showed no appreciable difference between control samples.

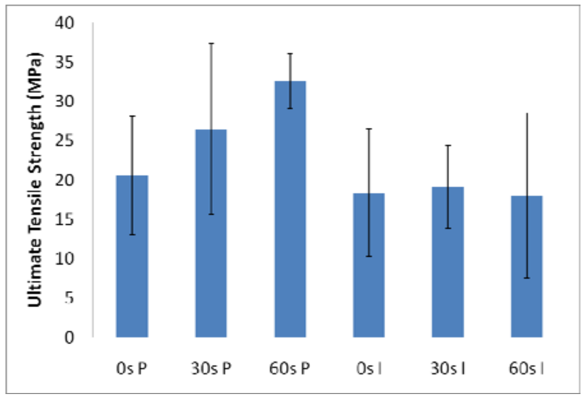

Figure 1. Micro tensile strength of Ar/methane plasma treated dentin/composite bars at various plasma treatment times. Peripheral (P) and inner (I) dentin (3M adhesive/composite)

Conclusions: Our experimental results showed that atmospheric plasma treatment with methane addition could increase the dentin/adhesive micro tensile interfacial bonding strength. A more pronounced effect was observed in peripheral dentin when compared to inner dentin. Non-thermal atmospheric plasmas have great potential in dental composite restoration applications for improved performance. Further investigation of plasma treated dentin is required to determine mechanism.

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