Water Trees? What Can New Technology Provide?

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During the last few decades, several trends have developed in the formulation and marketing of current dentin bonding agents in an attempt to simplify their application and amount of time required to apply them. One of the trends was the development of combined enamel/dentin conditioners, or so-called "all-in-one" or single-bottle adhesives. Recently, with expanded indications, they were marketed as single-bottle universal adhesives.

Adhesion to enamel and dentin is no longer a clinical concern since the discovery of etch-and-rinse (total-etching) and self-etching adhesives. But the success of single-bottle bonding resins still remains questionable with respect to durability.

Critical Issue

A critical issue with all-in-one adhesives is that even if they are thick enough to polymerize, their composition is very acidic and very hydrophilic. This means that they attract and absorb water, leading to leaching of unpolymerized monomers or hydrolytic degradation products through water-filled channels called "water trees" (Figure 1).

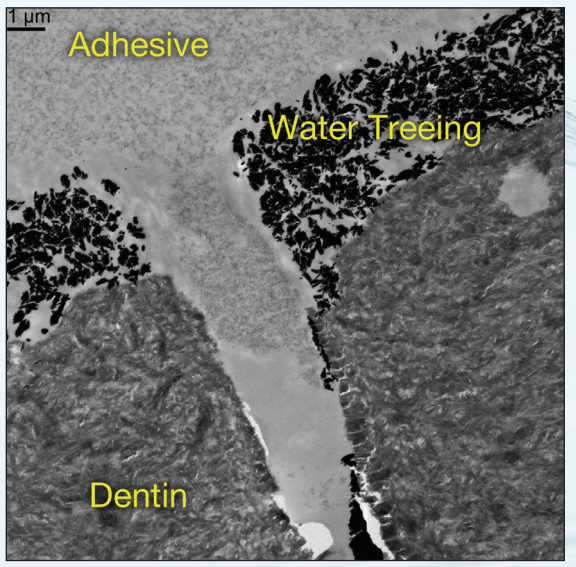

Figure 1. Water trees in a leading universal adhesive. *(Image courtesy of Franklin Tay, BDS, PhD.)*

Experimentally, the presence of water-filled voids and channels is disclosed by soaking bonded specimens in silver nitrate solutions. The silver nitrate diffuses into the water-filled spaces. Once reduced, black silver deposits are formed (Figure 1). These channels pass from the hybrid layers, through the adhesives, to the adhesive interface. These water channels have been given the term water trees by Tay and Pashley. When present, they provide the most direct pathways for water movement across the polymerized adhesive layers, which may cause degradation of the adhesive resin matrix by hydrolysis.

Universal Adhesive With MDP and AMIDE Technology

Kuraray's CLEARFIL Universal Bond Quick uses the new technology supporting that AMIDE monomers have high hydrophilicity, as compared to the HEMA monomer, and demonstrate high curing ability. The most significant characteristic is once cured, water absorption of the adhesive is minimal and resists the formation of water trees. Experimental resins made with these AMIDE monomers show how physical properties are maintained after water storage (Figure 2). When this new adhesive was tested after water storage and silver nitrate treatment, formation of water trees was minimal (Figure 3). This technology could be considered a major breakthrough to form more durable one-bottle universal adhesives.

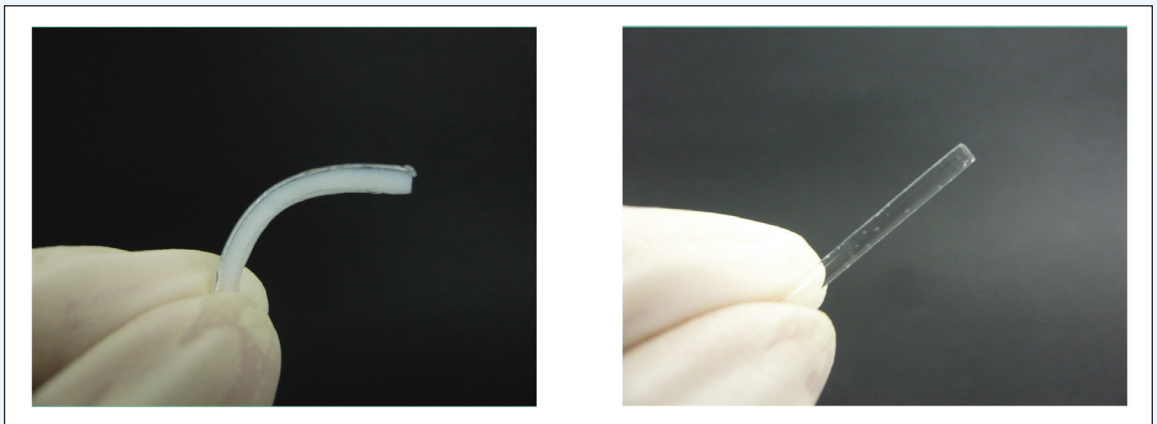

Figure 2. New AMIDE monomer maintains physical properties after water storage.

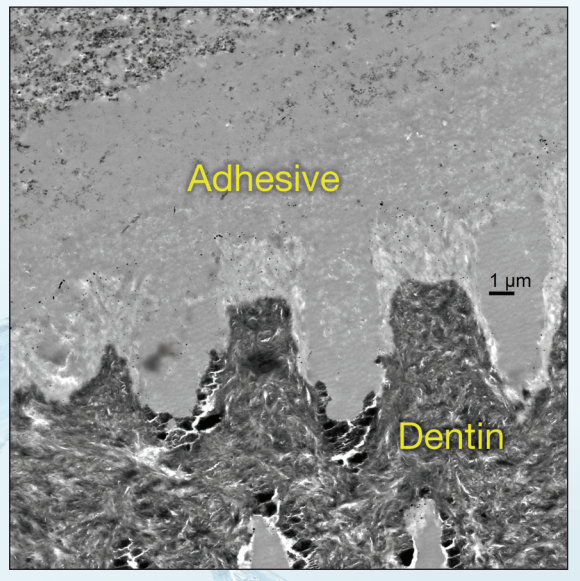

Figure 3. CLEARFIL Universal Bond Quick with no extensive water tree formation. *(Image courtesy of Franklin Tay, BDS, PhD.)*

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