



Effects of functional monomers and photo-initiators on the degree of conversion of a dental adhesive

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ABSTRACT

Besides functional and cross-linking monomers, dental adhesives contain a photo-initiator system for polymerization, thereby providing physico-mechanical strength to the adhesive-tooth interface. Few studies have investigated the effect of the functional monomer and polymerization-initiation system on the polymerization efficiency of the adhesive. Here, we tested the effect of two different functional monomers (MAC-10 vs. SR) and two photo-initiator systems, camphorquinone-amine (CQ) vs. borate (BO), on the degree of conversion (DC) of different adhesive formulations. The DC of the CQ-cured adhesive formulations was significantly affected by the MAC-10 monomer. This should be ascribed to the known inactivation of the amine co-initiator through acid–base reaction. However, the SR monomer did not decrease the DC, which could be attributed to a “gel effect” or the so-called “Trommsdorff–Norris” phenomenon of enhanced DC with more viscous resins, and to the more favorable availability of C=C double bonds. In contrast, the DC of the BO-cured adhesive formulations was not affected by any acidic monomer. It is concluded that the degree of conversion of an adhesive can be affected by the functional monomer, but this depends on the kind of photo-initiator system used. As bond durability depends, among other factors, on the strength and thus degree of conversion of the adhesive, potential interaction between adhesive ingredients and the photo-initiator system definitely needs to be studied further.

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1. Introduction

Despite dental adhesive technology having made significant progress during the last decades, the bonded interface at the dentin remains the Achilles' heel of tooth restoration [1]. Not only is a high-strength and stable bond to dentin required, but also a long-lasting seal at the restoration margins should be obtained. The hybrid layer produced at the interface with dentin was defined by Nakabayashi et al. [2] as “the structure formed in hard dental tissues by demineralization of the surface and subsurface, followed by infiltration of monomers and subsequent polymerization”. Today's adhesives basically form different kinds of hybrid layers on dentin, depending on whether an “etch-and-rinse” or a “self-etch” approach is applied. Phosphoric acid etching is now regarded as acting much too aggressively on dentin. Indeed, phosphoric acid

denudes collagen nearly completely, thereby removing the natural protective effect of the hydroxyapatite (HAp) shell [3]. In contrast, so-called “mild” self-etch adhesives leave the HAp around the collagen, providing an opportunity for the functional monomer to also chemically interact [3–6]. This latter primary chemical interaction is thought to prolong the lifetime of the bond to dentin [3–6].

In addition to functional monomers, such self-etch adhesives contain cross-linking monomers [7], which are needed for adequate polymerization of the adhesive layer and thus to provide physico-mechanical strength to the interface. New adhesives are currently the subject of abundant bond-strength and leakage/sealing studies [8,9], and their interfacial interactions with enamel and dentin are characterized using a multitude of microscopy techniques [8,10–13]. Such studies are essential in screening adhesives for their bonding potential [8]. However, the polymerization efficiency of the adhesive is also of great importance to the strength and stability of the bond. Several studies have investigated the effect of (co-) initiators [14], solvents [15] and methacrylate

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