Influence of co-initiators on the degree of conversion of self-etching adhesives

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INTRODUCTION

Photoinitiator systems based on camphorquinone (CQ) are widely and most successfully used as visible light photoinitiators in dental restorative resins. Although CQ is able to start the photopolymerization process by itself, the process will occur at low rate. To speed up this reaction different kinds of co-initiators are used. The most frequently used co-initiator for dental adhesives is aromatic amine: ethyl-4-dimethylaminobenzoate (EDB). Despite their good chemical and mechanical properties, this system presents some disadvantages. The main disadvantage of this photoinitiator system (CQ/EDB) is poor color stability – using amine in photoreaction causes the change of color of the material to red/brown; the toxic and allergenic action of amines compounds is also well known. Also, acid-base reaction between the acidic monomers of self-etching adhesives and the amine reduces the concentration of the formed amine radical.

Aim of this study was to evaluate the influence of the co-initiators Irgacure 819 (2,4,6-trimethylbenzoylphenylphosphine oxide), Lucirin TPO (2,4,6-trimethylbenzoyldiphenylphosphine oxide) and DPIHP (diphenyliodonium hexafluorophosphate) on properties of the self-etching adhesive, and specifically to reveal their influence on the degree of conversion (DC) of adhesive.

METHODS AND MATERIALS

The model of the adhesive used in this study consisted of acidic functional monomer, 2-hydroxyethyl methacrylate (HEMA: Sigma-Aldrich, USA) and urethane dimethacrylate (UDMA: Sartomer, USA) with a mass ratio 45/55 (HEMA/UDMA). This composition is similar to that used in commercial adhesives formulations. 24 hours shaking was required to yield well mixed resin solution. All models adhesives contained CQ. Quantity of CQ was chosen experimentally. Each co-initiator was added to adhesive that already contained CQ. The all models of adhesives were cured for 20 seconds with a commercial visible-light-curing unit. The degree of conversion of the adhesive model was monitored using Nicolet FTIR spectrophotometer equipped. One drop of adhesive solution was placed on the horizontal face of diamond crystal. The change in the ratio of band intensities measured at 1637cm^{-1} to that at 1608cm^{-1} was monitored during polymerization. The DC was calculated based on the time-dependent decrease in the absorption intensity band ratios before and after light curing.

RESULTS

0.4 % of CQ was chosen as optimal percent for obtaining better results of the DC of experimental adhesive (table 1).

Table 1 - Quantity of CQ and corresponding DC of the experimental adhesive

	Quantity of CQ					
	0.10%	0.20%	0.30%	**0.40%**	0.50%	0.60%
DC of adhesive, %	48	52	54	**57**	57	57

EDB, Irgacure 819, Lucirin TPO and DPIHP were added to the blend that previously contained 0.4% of CQ. The percent of co-imitators and degree of conversion of adhesives were recorded and calculated (table 2).

Table 2 - Quantity of different co-initiators and corresponding DC

EDB	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%
DC, %	48	52	57	58	58	58
Irgacure 819	0.5%	1.0%	2.0%	3.0%	3.5%	4.0%
DC, %	67	70	74	75	75	75
Lucirin TPO	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%
DC, %	64	69	72	73	73	73
DPIHP	0.4%	0.6%	0.8%	1.0%	1.2%	1.5%
DC, %	54	62	72	74	74	74

CONCLUSION

Addition of EDB to CQ-contains system did not show improvement in DC of adhesive. Whereas, addition of the Irgacure 819, or Lucirin TPO, or DPIHP to the CQ-contains system revealed dramatic improvements in DC of the adhesive. Thus, using these co-initiators may increase significantly the mechanical properties of adhesives and as result of this has excellent potential to improving adhesion properties of the dental adhesives.