Degree of Vinyl Conversion in Experimental ACP Composites

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A unique amorphous calcium phosphate (ACP)-based composite with the potential to arrest caries development and regenerate mineral-deficient tooth structures has recently been developed. When embedded in polymerized methacrylate matrices and exposed to an aqueous environment, ACP releases sufficient levels of remineralizing calcium and phosphate ions in a sustained manner to promote redeposition of apatitic tooth mineral. The aim of this study was to assess the degree of vinyl conversion (DVC) attained in experimental composites based on zirconia-modified ACP and photo-activated resins.

The composites were made from the resins comprising: 1) ethoxylated bisphenol A dimethacrylate (EBPADMA), triethylene glycol dimethacrylate (TEGDMA), 2-hydroxyethyl methacrylate (HEMA) and methacryloxyethyl phthalate (MEP) (ETHM series with varying EBPADMA/TEGMA molar ratios assigned 0,5 - ETHM I, 0,85 - ETHM II and 1,35 - ETHM III), and 2) 2,2-bis[p-(2'-hydroxy-3'-methacryloxypropoxy)phenyl]-propane (bis-GMA), TEGDMA, HEMA and zirconyl dimethacrylate (BTHZ series). Both ETHM and BTHZ resins were photo-activated by the addition of camphorquinone and ethyl-4-N,N-dimethylaminobenzoate. In order to asses a possible effect of filler particle size on CR, resins (60 mass %) were blended with 40 mass % of either milled ACP (mACP; median diameter d_m = 0.9 μm) or coarse ACP (cACP; d_m = 6.0 μm). Composite specimens were polymerized by irradiating them for 40 sec with soft start mode (LED curing unit Bluephase; Ivoclar Vivadent, Liechtenstein). The DVC was calculated as the % change in the ratio of the integrated peak areas between the aliphatic and aromatic absorption bands (eight specimens/experimental group) determined by Fourier transform infrared spectroscopy (Perkin Elmer 2000 spectrometer; Perkin Elmer, UK).

One-way ANOVA indicated that the differences in DVC of tested composites are significant ($p<0,001$). The highest DVCs were attained in mACP-BTHZ, cACP-BTHZ and mACP-ETHMIII formulations (Table 1).

Table 1: Composition of tested materials and the attained DVC.

Material number	Filler type	Resin matrix	Mean	Std. Dev.
1	mACP	ETHM I	73,63	2,00
2	cACP	ETHM I	72,93	1,94
3	mACP	ETHM II	71,90	1,10
4	cACP	ETHM II	74,92	1,69
5	mACP	ETHM III	80,31	2,69
6	cACP	ETHM III	75,43	1,93
7	mACP	BTHZ	82,77	1,46
8	cACP	BTHZ	82,23	0,90

DVC of tested ACP composites (on average (76,76 ± 4,43) %) compares well with or is even higher than the DVCs reported for the majority of commercial materials. Since the composites with high DVC usually exhibit high polymerization shrinkage, future studies of ACP composites will focus on determining the polymerization shrinkage of these materials.