NEW LAMP FOR LIGHT CURABLE DENTAL COMPOSITES
I – PRELIMINARY RESULTS

Marc J.M. ABADIE, Joêl COUVE & François DURET

Laboratory of Polymer Science & Advanced Organic Materials LEM/MAO –
University Montpellier 2, Place Eugène Bataillon – 34095 Montpellier Cedex 05 – France.
e-mail: abadie@univ-montp2.fr

Abstract

We have tested a new plasma lamp, the Apollo 95^E, manufactured by DMDS (Dental Medical Diagnostic Systems) and recently introduced into the French market. The initial results of the photopolymerisation of dental composites show that, compared to traditional lamps used in dental surgeries, the time saving perspectives for the practitioner are very acceptable. The experiments carried out by power compensation photopolymerisation permit the quantification of the exothermicity of the reaction of reticulation and show that an exposure of 3s using the Apollo 95^E gives better results than an exposure of 40s using a classic lamp.

Introduction

All photopolymerisable dental composites – composites 1st, 2nd and 3rd generation, cement glass ionomers – risk the methacrylate functions through modified epoxyde acrylates resin from Bowen (Bis-GMA), the modified urethane acrylates or even modified silicone acrylates used as oligomers. Generally they are mixed with mono-functional (MMA, HEMA) or multi-functional (EGDMA DEGMA, TEGMA etc.) monomers so as to decrease their viscosity. The methacrylate functions are very reactive and permit, during their polymerisation reaction, the formation of a three-dimensional, reticulated and infusible lattice. This reaction confers the mechanical properties to the polymer matrix, which are largely improved due to the presence of mineral charge. The photo-initiator, generator of radicals, generally camphoroquinone, absorbs under the visible (blue light) at 458 nm [(1)].

Experimental Protocol

We modified the photocalorimeter [(2)] – DSC classic with power compensation, surmounted by a insolation unity (3rd generation) – in replacing the luminous source by the Apollo 95^E lamp and then the classic ESPE lamp. The wave-guide is fixed to a micrometric screw above the measure head of the DSC enthalpic analyser, permitting to adjust the intensity received by the analogical sample. The Apollo 95^E emits a visible light between 400 and 500nm, the same for the ESPE lamp.

The measured enthalpy is directly proportional to the number of acrylate functions involved in the reticulation reaction [(3)]. The reactivity coefficient **k** is measured using the autocatalytic equation.

$R = -dC/dt = kC^m (1-C)^n$

C is the degree of conversion and m and n the part orders of reaction, respectively the initiating reaction (m) and propagation (n).

The resin tested is Z100™ A2 from 3M[3]. The ratio τ of resin is measured by thermogravimetric analysis TGA, τ[resin] = 19.09% (τ[charges] = 80.91%). The Apollo 95E lamp possesses four insolation modes: 1s, 2s, 3s, and SC mode (5.5 s made in two successive flashes). The ESPE lamp was used during 20s and 40s.

The luminous intensity is fixed at I = 10 mW/cm^2, the samples were analysed at 32°C±2°C.

Experimental Results

An example of a thermogramme – **figure 1**, and kinetic analysis – **figure 2** are given for the Z100™ A2 exposed during 3s to the plasma lamp.

The results of the different insolation modes are brought together – **table 1,** for the Apollo 95E lamp and table **2**, for the ESPE lamp.

We observe **table 1,** that the values of **ΔH** and **k** increase with the time of insolation and are optimal for the 3s mode. The time of induction decreases normally, the quicker the reaction the shorter the time of induction. – except for the SC mode; this could be explained by the fact that there are two successive flashes of variable power and their effect increases the exotherm peak (increase of enthalpy, ΔH = 137.9 J/g) and decreases the reactivity (k = 10.771/min).

For the samples subjected to the ESPE lamp, we can remark – **table 2,** that there is perceptible increase when the insolation time is doubled but that the velocity coefficient remains far smaller than that observed using the plasma lamp. However the time of induction is far higher than with the plasma lamp, and this represents a smaller reactivity.

Conclusion

In terms of reactivity, the dental composite subjected to the plasma lamp gives kinetic values far superior to those given by the classic photo-reticulation lamp and even more so for short lengths of time, just a few seconds compared to 20s to 40s of insolation.

Bibliography

(1) M.J.M. ABADIE & B. MOHAMMADI
Photopolymérisation en Odontologie – 1° Etude spectrométrique des systèmes photoamorceurs
J.Biomat. Dent., 9, p. 89-100 (1994)

(2) M.J.M. ABADIE & B.K. APPELT
Photocalorimetry of Light Cured Dental Composites
Dent. Mat., 1 p. 6-9 (1989)

(3) M.J.M. ABADIE & M. ROUBY
(4) Réactivité de Résines Composites Dentaires – 2° Description d'un protocole d'étude pour résines photopolymérisables
(5) J. Biomat. Dent., 11 p. 141-148 (1996)

Figure 1: DPC Graph line of the sample Z100™ A2 subjected during 3s to the Apollo 95E lamp.

Figure 2: Determination of the velocity coefficient for the sample Z100[TM] A2 subjected during 3s to the Apollo 95[E] lamp.

Mode	**ΔH**	**k**	**Time of induction**
	(J/g)	**(1/min)**	**(s)**
1s	82.65	9.99	2.6
2s	109.5	12.87	2.5
3s	127.3	15.32	2.4
SC	137.9	10.77	2.9

Table 1: sample Z100[TM] A2 subjected to the Apollo 95[E] lamp.

Mode	**ΔH**	**k**	**Time of induction**
	(J/g)	**(1/min)**	**(s)**
20s	93.7	5.10	12.1
40s	108.3	5.37	10.4

Table 1: sample Z100[TM] A2 subjected to the ESPE lamp