Monomer Conversion Analysis of BisGMA/TEGDMA Based Dental Restorative Material

Program #4076

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INTRODUCTION

- The final monomer conversion of the resin based dental restorative cements is very important property for these materials. As a rule, high degree of conversion is followed by:
  - Improved mechanical properties,
  - Low monomer migration from the material to oral fluids,
  - Slow aging rate of the restoration
- However, it is almost impossible to achieve full (100%) monomer conversion, since it depends on variety of conditions:
  - Monomer properties.
  - Environmental temperature.
  - Initiation system.
  - Radiation intensity in case of light curing process.
- Chemical and light activation methods are widely in use in these materials. Each one of those methods can be used as the only way to initiate the polymerization, or as the combination of the both of them. Although the light curing initiation happens instantly and the polymerization occurs mainly, if not only during the irradiation, the chemical initiated polymerization has a parabolic kinetic profile of the reaction rate vs. time curve.
- One of the most useful light polymerization initiators in dental materials is Camphor Quinone (CQ) that generates two free radicals for each CQ molecule as a reaction product with radiation of 450nm. Ethyl 4-dimethylamino Benzoate (EDB) is used to stabilize the free radicals that formed and to prevent their recombination.
- The concentration of the light curing initiators is therefore in linear correlation with the number of the free radicals that are formed after the irradiation. However the excess of EDB could act as an inhibitor and therefore to decrease the degree of conversion.

OBJECTIVE

The purpose of this study was evaluate the degree of conversion (DC) of experimental restorative dental material based on 60/40 blend of BisGMA/TEGDMA resin in dual and auto curing modes

METHODS

Eight experimental materials (A-H) were prepared from BisGMA/TEGDMA 60/40 blend, loaded with 61wt% inorganic filler and with varying concentrations of CQ and EDB:

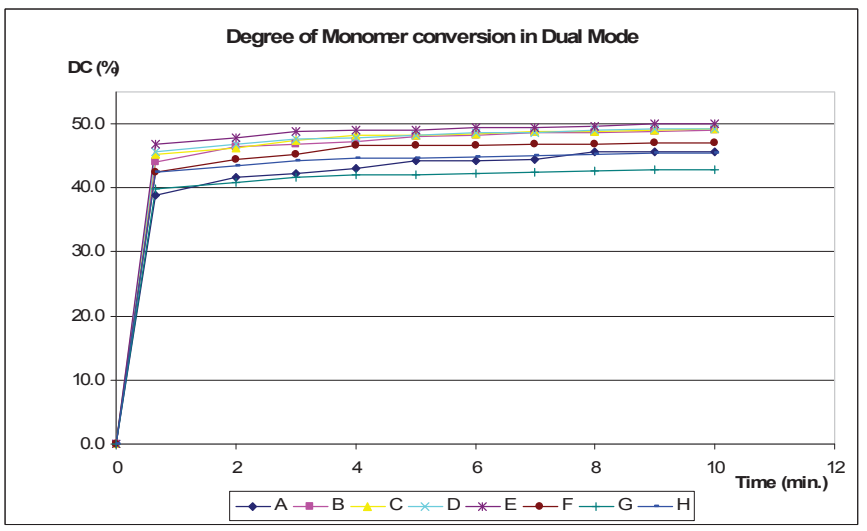
Sample	wt% of CQ	wt% ofEDB
A	0.10	0.10
B	0.18	0.18
C	0.20	0.20
D	0.30	0.30
E	0.40	0.40
F	0.50	0.50
G	1.80	0.00
H	1.80	3.60

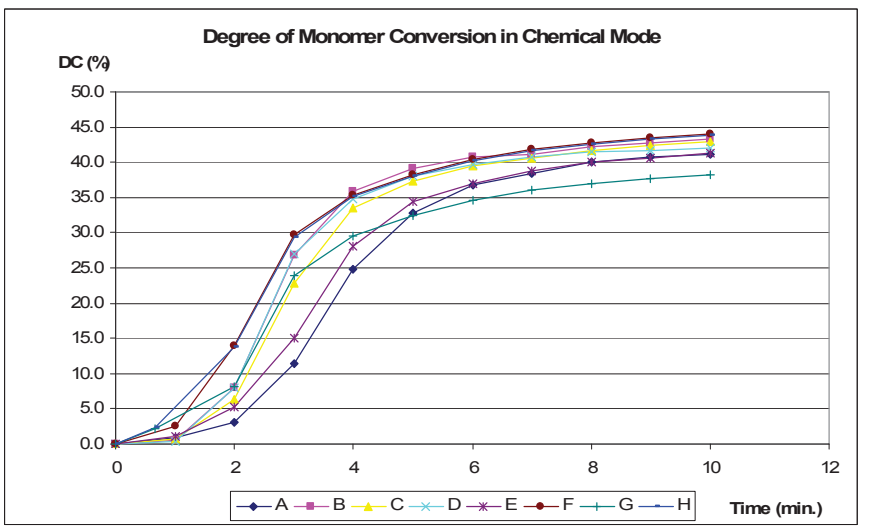
All the samples were tested for their DC in two modes:

1. Dual curing mode – the samples were irradiated for sec. with led lamp at ~450nm (Vivadent) and then allowed to polymerize for additional 10 min.
2. Auto curing (chemical) mode – the samples were allowed to polymerize without the light initiation (under the yellow light) for 10 minutes.
   - IR spectra were taken using FTIR spectrometer (Nicolet) with the attenuated total reflectance (ATR) device.
   - The equation below was used to calculate the DC from the changes in absorption peaks of the aliphatic double bonds at 1638cm^{-1} and normalized by the absorption of the aromatic bonds at 1608cm^{-1}:

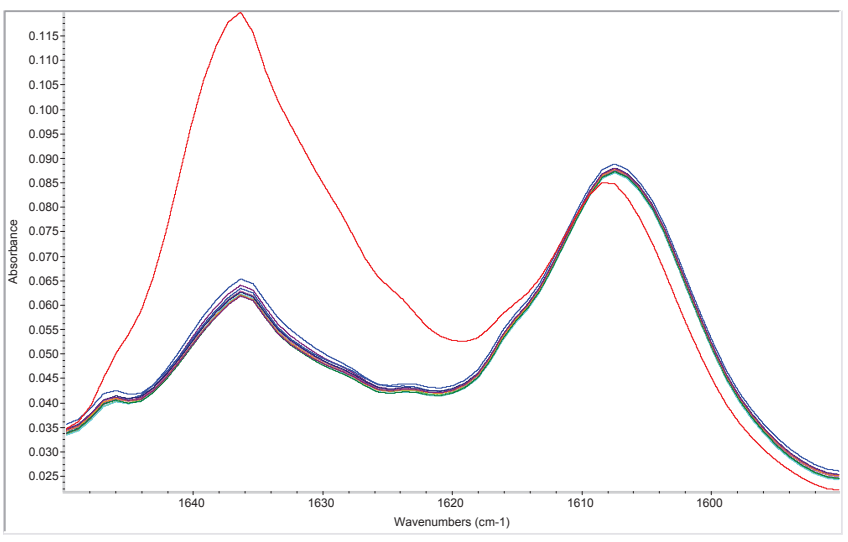
$$DC(\%) = 1 - \frac{(1638cm^{-1}/1608cm^{-1})\ cured}{(1638cm^{-1}/1608cm^{-1})uncured} \times 100$$

RESULTS

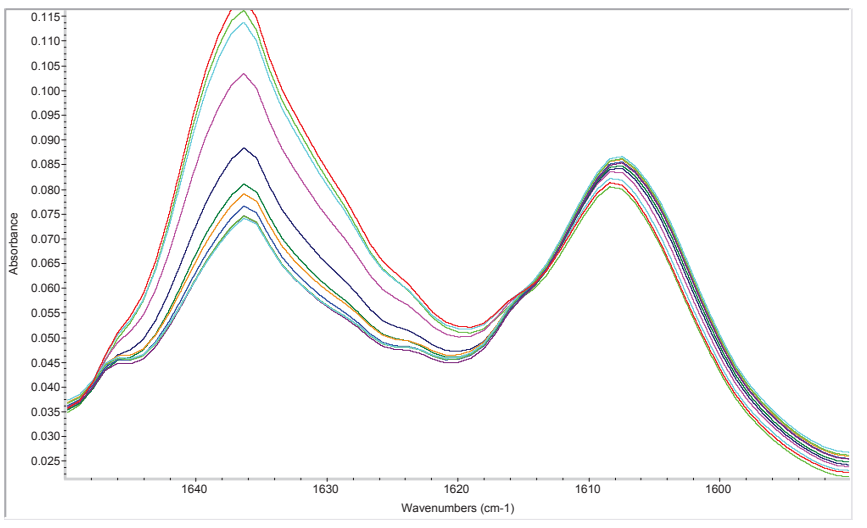




Dual mode polymerization



Chemical mode polymerization



Changes of the absorption peak heights at 1638cm^{-1} and 1608cm^{-1}

DISCUSSION

- For the light curing mode (immediately after the irradiation), the higher DC was obtained for the variations with CQ/EDB ratio 1:1. For the samples without the EDB and with CQ/EDB ratio 1:2 G and H , the initial and the final DC were lower by 15%.
- For the chemical mode, the final DC for all samples with EDB was significantly higher than for the sample without EDB (G).
- In the dual curing mode, for the samples A-F and H, the higher initial DC value followed by higher final DC. For the sample G, the chemical polymerization seems to be significantly lower than for all the samples that included EDB.
- There was no significant increase in DC observed for the samples with CQ/EDB ratio 1:1 that contained higher CQ concentration than the sample C (0.2% wt CQ).

CONCLUSIONS

- The optimal results were obtained for the sample C, with contained 0.2% wt of CQ and EDB.
- Excess of the EDB lowers the light and the chemical polymerization both for the dual and auto curing modes.

FUTURE WORK AND RECOMMENDATIONS

- We will examine various monomers and initiation systems for their maximum DC value.
- Different analysis methods will be involved in order to investigate the polymerization reaction mechanism and kinetics.

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