

IMPLICATIONS OF THE FTIR TECHNOLOGY IN DENTAL MEDICINE

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Abstract: The mechanical, physical and biocompatibility properties of the composites and of the photopolymerizable adhesive systems can be directly influenced by the degree of conversion after polymerization. The FTIR spectroscopy is a technique, by which the degree of conversion of the double residual bonds C=C can be determined from the composition of composite resins and the adhesive systems.

Cuvinte cheie: FTIR, grad de conversie

Rezumat: Proprietățile mecanice, fizice, de biocompatibilitate, ale compozitelor și sistemelor adezive fotopolimerizabile, pot fi direct influențate de nivelul gradului de conversie obținut după polimerizare. Spectroscopia FTIR este o tehnică prin care se poate determina gradul de conversie al dublelor legături reziduale C=C din compoziția rășinilor compozite și sistemelor adezive.

A polymerization reaction is a reaction which transforms unsaturated monomers into polymers, whose chain is made up only of carbon atoms. (1) The polymerization of composite materials and of adhesive systems, with regard to the setting reaction, is never complete.

The medium value of the degree of conversion of the composites is of 43-75%. (2) The polymerization reaction and the degree of conversion of the monomers depends on:

- polymerization type: photo-, auto-, or dual cure,
- place where reaction starts (in the thickness of the hybrid layer, for the photopolymerizable systems, or at the surface, for the autopolymerisable adhesives, or dual cure),
- number of available bonds C=C (1)
- temperature of reaction (3),
- structure and functionality of the monomers (4),
- quality of the solvents (5),
- presence of oxygen, contact which can not be avoided during the clinical applications (6),
- humidity (7),
- viscosity(8),
- polymerization protocol related to the light intensity (9),
- type of photoinitiator used (7)

An inadequate polymerization within the hybrid layer makes this function as a 'reservoir' which releases potentially cytotoxic monomers. If HEMA and TEGDMA are unpolymerized, they can cause apoptosis and cell death.(1,10)

The doctor, too, develops clinical methods for enhancing the conversion rate through:

- keeping a minimum distance between the active head of the polymerization lamp and the polymerized material,
- application of layers of composite material with acceptable thickness,
- increase in irradiation time,
- choosing a polymerization lamp.(11);

The mechanical and physical properties can be directly influenced by the degree of conversion resulted from the polymerization.

The FTIR spectroscopy technique can be used for

analysing materials in gas, solid and liquid states. It is based on the interaction between electromagnetic radiations and chemical vibrations of the atoms that make up the material.

In order for the material to absorb the radiations in the infrared region two conditions must be met:

- There must be a coincidence between the infrared frequency and the vibration of the molecules.
- The nature of vibrations must cause dipole changes during the vibrations.(2)

In order to make a quantitative analysis of the unreacted methacrylate groups, the absorption band from 1635-1640 cm⁻¹ is generally used due to its valence vibrations of the double C=C bonds of methacrylate groups. As an internal standard is used the absorption band C-C from 1610-1608 cm⁻¹, due to the valence vibrations of the aromatic nuclei in the Bis-GMA molecule. The report of absorbent intensities C=C/C-C is measured before and after the polymerization. If the material contains no Bis-GMA or if the band of the internal standard is not highlighted sufficiently, other spectral bands can be used as an internal standard.

In order to determine the pics absorbance, the baseline method is used. The corresponding baseline is drawn, and the value of absorbance of the baseline is reduced from the pics absorbance value, to the corresponding waveline number.(12)

$$DC = \left[1 - \frac{\left[\frac{Absv_{C=C}}{Absv_{ref}} \right]_{Polimer}}{\left[\frac{Absv_{C=C}}{Absv_{ref}} \right]_{Monomer}} \right] \times 100$$

CONCLUSIONS

Knowing the degree of conversion from monomer into polymer of the composite resins and of the adhesive systems, new information on their degree of polymerization can be obtained, as well as on the cytotoxic influence, the quality and on the time lastingness.

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By using the FTIR technique, a better understanding of these dental materials is gained.

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