# Polymers Adhesives Reinforced by Nanotubes

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## INTRODUCCIÓN

The project proposal consists of carbon nanotubes reinforced composite adhesives and filling polymers mechanical properties and how it relates to a total dental restoration. It will be based on the manufacturer's specifications, experimental data, mechanical test and computer simulation under an adequate statistic experiment design. The goal of dental adhesive is to create a strong bond against the residual tooth, as well as a white composite filling, which is, usually, some other polymer.

The purpose of this study is to analyze the mechanical properties of different nanotubes reinforced dental nanocomposite adhesives using Vickers indentation hardness, Three Point Bent and Electrical Conductivity tests. In addition, it will focus on the mechanical properties effects on the overall restored tooth, by performing macro experiments, mechanical and computer simulation tests, under specifications given by the manufacturer. This data is obtained by macro tension and shear rupture stress of the restoration. Then, observe the difference between the nanocomposite mechanical properties and the macro composite adhesive mechanical test results of total restoration

Another interesting comparison is the computer model stress analysis given by the nanocomposite materials and the macro test total restoration. Finally, these results will be compared to the standard adhesives.

The X-R Diffraction, Scanning Electron Microscopy (SEM) and Disperse Electron Spectroscopy (EDS) experiments will confirm and determine the sample nanocomposite adhesives-filling structure type and chemical composition. An expected and similar adhesive test will show an amorphous structure.

The bonding nanocomposites will be tested with the same nanotubes and matrix concentration. The mechanical, electrical and computer simulation test will show mechanical and electrical properties. In addition, the nanocomposite results will be compared with the macro tension and shear rupture stress results and the respective computer model stress analysis.

Expected Significance: One of the most important expected results is that the amorphous structure is present in all nanocomposites, adhesive and filling experiments, showing strong possibilities of bonding with another neighbor's molecules. The thermodynamic discussion will be extended to the bonding advantages for this type of structure.

In order to maximize time and most important to avoid exposing the patients to marginal infections, the optimal adhesive selection will be when the clinician can choose one for a specific restoration.

Expected Findings: Bonding quality is related to:

1) The type of the nanotubes matrix reinforced adhesive.
2) Time Delay of photo-polymerization, used variables as a type of nanotubes to reinforce the matrix adhesive.
3) Time Delay etching treatment of water evaporation control and Time Delay obtained by applying different curing light wavelength sizes.

The composite will show better molecular organization, which avoids internal stress, bonding defect and failure restoration. Sheet Grafenes Carbon Nanotubes or Buckyball Nanotubes reinforced molecules will be used to strengthen the matrix adhesive. By doing this, it will create a new nanocomposite material with an extraordinary improved strength. Lastly, the element chemical composition provides the opportunity to predict the type and strength of the bond.

Six dental adhesives will be used as stress absorbers nano-sized filler particles into the matrix to improve the mechanical-electrical properties.

To create the hybrid layer, the fillers need time to flow through the collagen spaces. The Nanotube's density is not uniform; normally each area has different mechanical properties.

This distribution causes a weakness in the bonding link produced by the fast polymerization process affecting the atomic organization and is responsible for internal stress, leakage, or failure of restoration.

Therefore, the effect of time delay allows the Nanocomposite hybrid layer to obtain better organization, deeper diffusion and high quality of bonding mechanical properties.

## PROJECT

This project will show the possibility of manipulating some variables by adding carbon nano-tubes or buckyball carbon molecule to the nanocomposite adhesives, and delaying the start of the polymerization process, giving more time to organize a deeper diffusion on the interfibril collagen spaces without polymerization. It will show a more uniform structure molecular distribution to benefit the bonding quality, reflected on the nanocomposite mechanical properties

The first bonding variable that will be discussed in this research is the carbon nanotube type. The second is the water evaporation control. It is directly related to the time delay for the polymerization process to start. Both give more diffusing time for the carbon nanotubes reinforced adhesive to infiltrate into the smear collagen dentine spaces, resulting into a homogenous hybrid layer and structure distribution, avoiding internal stress, shrinkage, leakage and failure restoration, showing a representative higher strength, witch is our goal. This water is obtained from the etching pretreatment. When the water is removed, the amorphous nanocomposite reinforced adhesive promotes the spontaneous polymerization. The nanotubes that will be used in this project will be ~6% of the total weight adding carbon nanotubes, sheet of graphenes multywall nanotubes or buckyball carbon molecule,

Another bonding variable control is based on the nanocomposites adhesive and filling initiators related to the atomic disorder or entropy. By using different cure-light wavelength size, it can delay the photo-polymerization process, minimizing the initiators Gibbs's energy, and delaying the spontaneous polymerization. In addition, it will give more time to create a uniform structure, avoiding internal stress, leakage and failure the restoration

The mechanical test are given by Three point bent test, determining the composite Young Modulus and ultimate stress basis on the composite deflection, load and nanocomposite geometry dimensions. Stress-strain basis on the Young Modulus value E. Scratch (adhesion test), indentation Hardness properties, and the wear test will be performed to determine the friction coefficients.

The electrical properties as conductivity is obtained by apply the meter lead on both nanocomposite ends; one of them needs to be silver coating. The conductivity are related to reach the percolation conditions.The conductivity value is an inverse to the resistivity; Conductance G value is proportional to the conductor's channel numbers and is an inverse value to the resistance. In addition, the resistance is directly proportional to the résistivity value and decrease with the temperature. The conductivity in a nanotube is a function of the diameter and it has one dimension conductivity along the axis tube, as well as with the thermal properties. The graphite resistivity is given by μΩm. Interesting observation will be to compare all of theses nanocomposite properties with the macro mechanical test data

Finally, for a macro test, a restored sample of six-specimen will be created with the same type of teeth and the same combination of nanocomposite adhesive and filling. Each specimen will be performing mechanical Tension and Shear rupture tests. Material and evaluation tests are done from selected groups of restored teeth, to obtain the best adhesives and composite filling. This is why the restoration depends on the bond quality of the interface adhesive-composite filling,

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