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Assessment of optical and thermal degradation in dentistry

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Abstract: Analyzing the reasons for structural degradation and failure of the employed materials is crucial in order to forecast how well dental materials will perform clinically in the patient's mouth. The oral cavity is a challenging environment for bacteria to survive in because of the pH and temperature variations, as well as a range of challenges. The three most typical causes of dental material failure are poor material choice, poor design, or overuse. In addition, damage might happen while being repaired. Planning for failure, comprehending its causes, and taking the required steps are essential if you want to avoid material failure.

Keywords: *optical degradation, thermal degradation, dentistry.*

Introduction

To predict how well the clinical performance of the dental materials will perform in the patient's mouth, it is essential to analyse the causes of structural degradation and failure of the used materials. The mouth cavity is a hostile habitat with numerous stressors, pH and temperature variations, and pathogens. bad material selection, bad design, or overuse are the three most common reasons for dental material failure. Additionally, damage can occur while being corrected. It's essential to prepare to avoid failure, assess the causes, and put the required preventative measures into place in order to prevent material failure[1-4].

1) Optical degradation and assessment

1) Visual method

Subjective color identification involves visual color assessment. It is performed by reference color samples whose specification is known. In dentistry, shade guides are routinely used as standard color samples against the tooth to which it is compared. Some of the popular shade guides are Vitapan Classical, Chromascope, and Vita System 3D

Master. Visual methods are easier than instrumental measurements. However visual color perception may vary from one individual to another and might even vary. To have a realistic change of obtaining a color match, thousands of tabs are needed[5].

2) Instrumental color change

Instrumental color measurement uses the CIE system, where the color consists of three coordinates: L* ,a*, b*. Where, L* refers to the lightness coordinates, and a*, b* are the chromaticity coordinates in the red-green axis, yellow-blue axis.

$$\Delta E = \left(\Delta l^2 + \Delta a^2 + \Delta b^2\right)^{1/2}$$

Colorimeter: Colorimeter quantifies color by measuring three primary color components of light. Colorimeter has been shown to provide accurate and reputable measurements; however, they are not free of errors. Where, the spectrophotometer measures each wavelength of light. Spectrophotometer allows the integration of each wavelength. Digital imaging system allows appropriate calibration with object-camera distance, and digital camera settings), digital imaging method has been suggested as an alternative with reasonable accuracy and reliability. This is a more convenient and economical process than spectrophotometers or colorimeters[5].

5) Thermal degradation

Thermal analysis is a group of techniques that measures properties change as a function of temperature. These techniques are applied for the characterization, decomposition, thermal stability, and phase transition. The most commonly used methods are differential thermal analysis, differential scanning calorimetry, and thermo-gravimetric analysis.

1) Differential thermal analysis:

It measures the temperature difference of the sample under investigation and uses a thermally inert material as a reference against temperature or time. The temperature difference is then recorded while the sample and the reference are subjected to a controlled identical temperature program in an environment at a controlled uniform rate. It is used with materials of high melting points as metals, and ceramics[6].

2) Differential scanning colorimeter

It is a thermal analysis method that measures the difference in the amount of heat or the heat flow rate between the sample and an inert reference a function of time or temperature while both are subjected to controlled temperature, as seen in Figure 1. It measures the energy required to keep both the reference and the sample at the same temperature. It differs from the DTA that the sample and the reference are both at the temperature determined by the program. It is a qualitative method that measures temperature differences and has no quantitative data for energy. It measures the glass transition temperature, melting point, crystallization temperature, and the heat of crystallization[6].

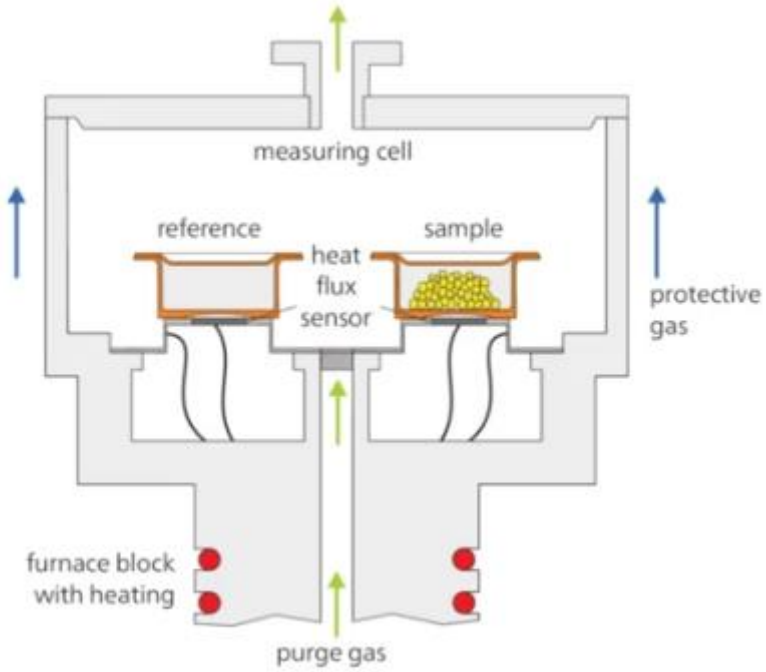

Figure 1: Differential scanning colorimeter

3) Thermo-gravimetric analysis

It is a technique where the mass of a substance is monitored as a function of temperature or time when the sample is subjected to a controlled temperature program. It measures the change in weight of the sample during heating or cooling. It is used to measure the glass transition and melting point including polymers and it also measures corrosion studies[6].

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