Mechanical and Thermal Properties of Dental Resin Nanocomposite Material Polymerized by Diode Laser

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Abstract. This paper evaluates the effect of continuous light and direct inversion of a two-wave laser valve to healing a resin-based material: Ivoclar Vivadent Tetric Nano Ceram Light Cured Hybrid renovated composite material on hardness, compression strength and temperature rise properties. Hardness was determined by (Amsler, KARL-KOLB/Germany) tester. Compression was determined by a universal testing and high temperature was measured using, the type L digital thermocouple. Samples are prepared then curing with irradiation time (10, 20, 30, 40, 50, and 60) Sec. The results obtained on the average (hardness, compressive strength and temperature) velocity of the Tetric N-Ceram composite resin composite disc polymerised with a diode laser as a function of exposure, compared with usage statistics (linear logarithmic, quadratic, linear and power). Diode Laser showed the highest mechanical property values and minimum temperature recorded in the reflective laser diode method was 2oc, the maximum temperature through direct method for a diode laser irradiation was 5.4° C, which is better at a tolerance of more 10° C. The study showed that a diode can enhance the mechanical and thermal property of the compound.

Keywords: mechanical properties, thermal properties, dental resin, nano composite, diode Laser.

1 Introduction

Properties of resin-based materials are extremely different because they affected by many operators, such as Hardness, compressive, tensile strength and raise temperature matter depend on composite material, exposure time, light-curing unit, radiance, emitted light spectrum and increase thickness [1, 2] . Hardness indicates for matter durability to the indentation and is one for most significant properties, been associated with compressive strength and resistance [3] . Hardness of composite materials affected by water with hydrolysis. Lower hardness of resin composite indicates poor physical connecting between the matrix and filler interface [4].

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First of all, most visual adhesives with visible from the visible spectrum of light it is sensitive to the blue part of the light and its highest absorption is 470 mm. The wavelength outside blue band is no effect to activate the polymerization response [5-7].

Light output properties were found from visible light processing units commonly applied not consistent.4,6 The devices produce the light which has a wide bandwidth (120 nm) typically fall between (400 - 520 nm) [8].The result energy density is around 400 mW/cm2, with the light intensity disintegrate at a geometric progression to distance and laser radiation own single narrow strap for wavelength which traveling in waves that is equal in phase spatially and temporally. Diode laser works during a bandwidth which include 42 nm between (454 – 496) nm for the visible spectrum of intensity that equal 800 mW/cm2 [9-13].

The radical polymerization given at, Propagation and Termination that have individual average for a polymerization; a monomers grow for polymers under a reaction of a radical series for polymerization. Photo chemistries explain the interaction light with the material to it induce a chemical reaction. The chemical reaction of light-treated teeth occurs at the ultraviolet and visible wavelengths for electromagnetic spectrum. A two molecules in a special arranging choose tupe of starting polymerization, and the imposed electromagnetic energy equation is[14, 15].

$$h\nu = hc/\lambda \quad (1)$$

Directness:

$$I = hc/\lambda \quad (2)$$

λ = Incident Light Wavelength .
h = Planck's const.
c = Light Velocity .

Induction to polymerization induces light on free radicals or ion and is commensurately to the monomer concentration. No light effect on the chain of diffusion. An important advantage in dentistry is the beginning of a large range of temperatures [16].

The goal of the present work is to estimate the impact of direct and a reflect light off continues wave laser diode to cure a resin-based material for hardness, compression strength and high temperature.

2 Materials and method

Light healing dental composite tested in the work is Ivoclar Vivadent Tetric Nano Ceram composite material Figure (1, a). The specimens are cured stratifing diode laser beam in a wavelength for (405 mm) Figure (1, b).

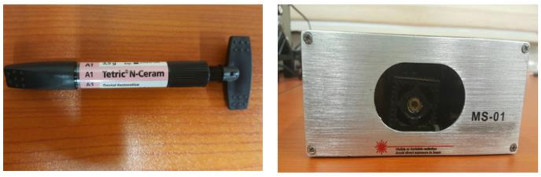

Fig. 1. a) Nano-hybrid co mposite b) diode laser.

Using the light detector before polymerization, the laser diode beam was measured. The BNC (Bayonet Neill–Councilman) connector output is a direct photo current out of a photodiode and the function of an incident light power (p) and wavelength (λ) can be got from a spectral responsively curve contened in data sheets for DET 10 A detectors, we transformed a photo current to the voltage (Vout) for viewing a digital voltmeter . This completed by add the external load resistance R_{load} output power divided :

$$P_{out} = \frac{V_{out}}{R\,(A)} \times R_{load}$$

All other specifications find by data sheet of the DET 10 A detectors, Then the laser beam diode power was checked and recorded and it appeared that the direct laser diode was (86.30 mW), while the laser diode reflection capacity was (W3.68 mW).

The samples were prepared using a 12 mm diameter conical stainless steel mold. The thickness of 1.5 mm of hardness and strength was blocked mold and then solved on the maps of the Islamic world and the bottom was installed a glass slide in the top three samples used for each group were polymerized for one minute Figure (2).

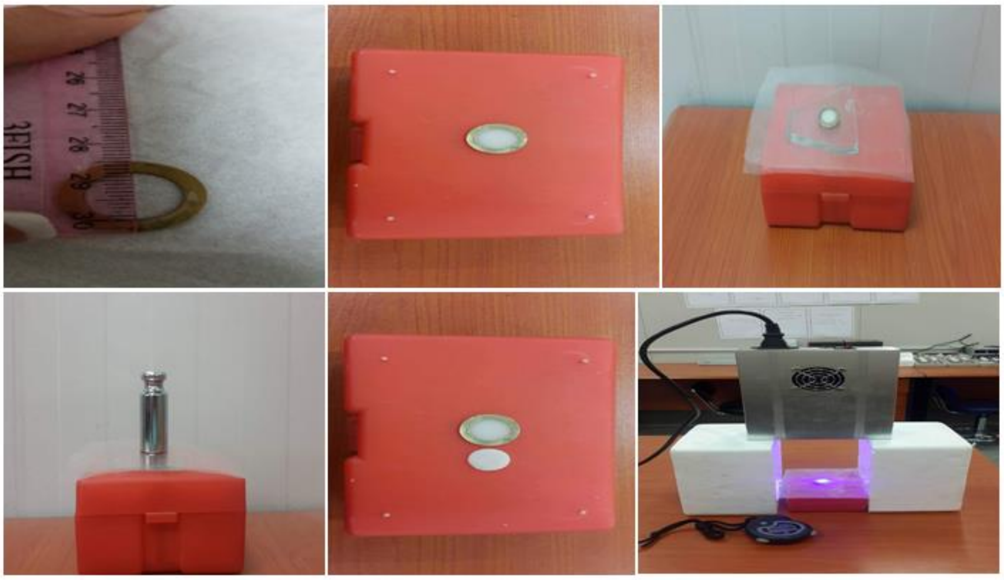

Fig.2. Method of preparing models and irradiation by diode laser diode.

2.1 Thermal properties

The L digital thermocouple use of measuring temperature from Nano Ceram and a time of laser radiation was recorded. The high temperature was evaluated every 10 seconds during laser (reflect and direct) radiation for 60 seconds. Temperature measurement repeat three times after a one hour standby period Figure (3, a).

2.2 Mechanical properties

a) **Hardness**: (Amsler, KARL-KOLB / Germany) The test used to measure the hardness in Figure 3b. The test load is set at (1 kg), the period of contact between difficulty and a solid 30 seconds. Measurements were taken directly from the scale, allowing five readings.

b)

c) **Compression strength:** The samples were cylindrical in size (12 x 1.5) Before the sample, all the samples were immersed in distilled water. Each sample was placed between two surfaces requiring high care axial loading, and eventually applied evenly. Intensity of pressure calculated on (10, 20, 30, 40, 50, 60), such as voltage in (N / $mm^{2)}$.

Compressive Strength = Force at failure (F) by newton over Minimum cross sectional area (A) by squar melemeter.

Fig.3. a.The L digital thermocouple; b.Amsler, KARL-KOLB machine; c. A universal testing machines

Results and discussion

Table (1,2,3 and 4) and figs. (4,5.6 and 7) the results were experimented with the average (hardness, pressure strength and temperature) of the active disk polymerized by a diode laser as a function of the time that was compared with statistics (logarithmic linear, quadratic, linear and energy) .

Table 1. Mean hardness equally a function of exposure time with different thickness.

Exposure Time (Sec)	Hardness Mean (VHN)
10	1003
20	1027
30	1041
40	1077
50	1103
60	1219

Table2. Compressive strength equally a function of exposure time.

Exposure time (sec)	Mean of Compressive strength (N/mm^2)
10	163.742
20	195.873
30	226.345
40	258.632
50	218.981
60	296.432

Table3. Mean Temperature increase with exposure time of N-Ceram Light Cured for direct diode laser.

Exposure Time (Sec)	Mean Temperature rise (^oc)
10	1.6
20	2.7
30	3.3
40	4.1
50	4.9
60	5.4

Table4. Mean Temperature increase with exposure time of N-Ceram Light Cured for reflecting diode laser.

Exposure Time (Sec)	Mean Temperature rise(^oc)
10	1
20	1.3
30	1.5
40	1.7
50	1.9
60	2

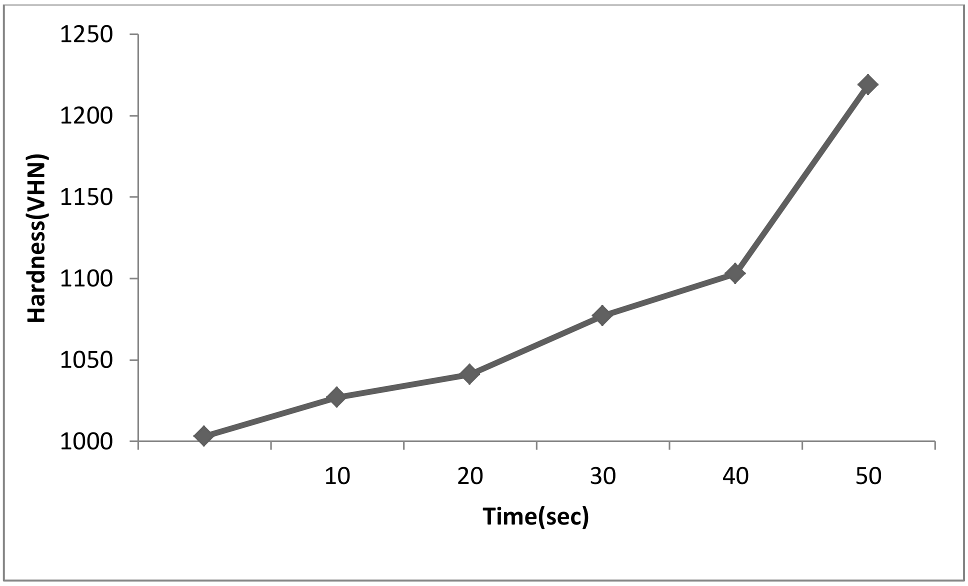

Fig. 4. The hardness (VHN) equally a function of exposure time.

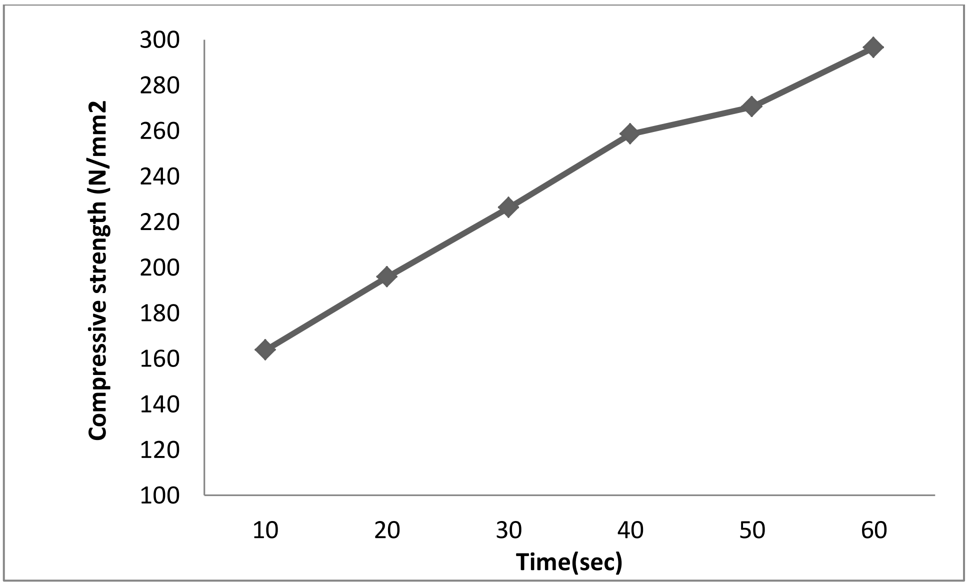

Fig. 5. The value of compressive strength as a function of time of experience.

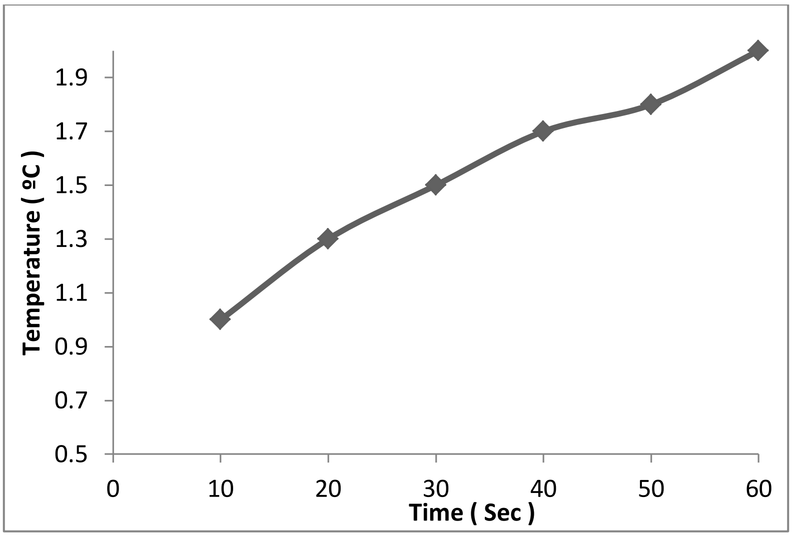

Fig.6. The relationship between temperature increases with time exposure to reflect diode laser radiation.

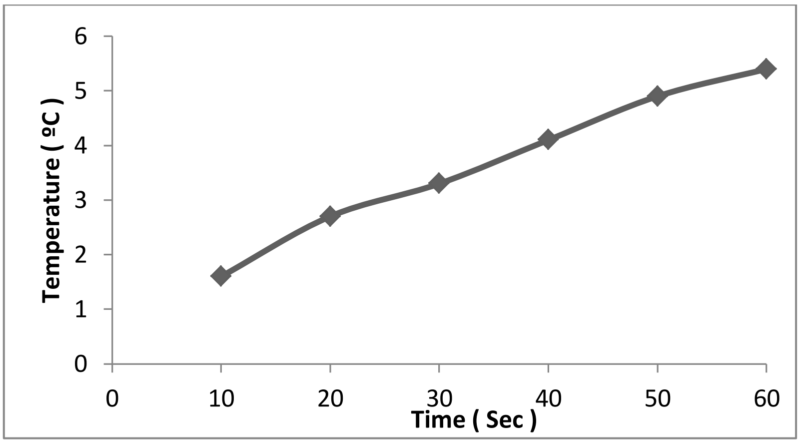

Fig.7. The relation between temperature increase with exposure time for direct diode laser radiation.

Discussion

Results showed longer irradiation time to be more effective in polymerization than the small irradiation time due to the spread of the lengthy irradiation time in deep parts of the model where it converts all the monomers to the polymer and this provides moral polymerization leading to moral mechanical properties [17]. The hardness experiment proved to more effective in the treatment of resin.The compressive strength showed the samples treated with laser diodes were high due to good polymerization enhanced by the laser diode.

Increasing the temperature of the compound resin during polymerization reduces the processing time. Concerns may arise regarding the effect of use high temperature compound on tooth paste that causes damage to the tooth structure. However, the minimum temperature recorded in the reflective laser diode method was 2^{o}c and the maximum temperature during irradiation with direct radiation to the diode laser was 5.4 ° C, which are better at a tolerance of more than 10 ° C [18, 19].

This study is a research, evaluate and compare the hardness, compressive strength and laser temperature. Different times of nano ceramic material. The study showed diode can enhance the mechanical and thermal properties of the compound.

Conclusion

The diode laser beam was applied to initiate photo polymerization of experimental dental Nano composites. Laser radiation has been promoted to treat resin, but its high cost and technical sensitivity have limited its use. Results obtained using eflect light and have a direct effect ongoing wave laser diode at low-density and wavelength of 405 NM were promising, especially with regard to low temperature rise in composite material samples. We got the fact that the laser's ability to polymerize the sample is efficient for photo therapy. Diode laser described as a promising light source for treatment whose wavelength is significantly absorbed by the initiator in composite resin and provides compressive strength for those in the traditional light treatment system To ensure light intensity efficiency and to improve processing values it is necessary to use more blue diodes and focus their light.

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