# Evaluation of Degree of Conversion and Microhardness of Activa Pronto and Beautifil flow plus - An Invitro Study

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**KEYWORDS**
Activa Pronto, Beautifil Flow Plus, degree of conversion, microhardness, restorative materials, resin composites

**ABSTRACT**
Introduction: The development of dental restorative materials has focused on improving mechanical and aesthetic qualities, with resin-based composites becoming widely used due to their ability to mimic natural teeth. These composites consist of a resin matrix, inorganic fillers, and a silane coupling agent, and their success depends on a high degree of polymerization. The degree of conversion (DC) affects the material's wear resistance, hardness, and longevity. To evaluate and compare the degree of conversion (DC) and microhardness of Activa Pronto and Beautifil Flow Plus composite resins.
Materials and Methods: In this in vitro study, specimens of Activa Pronto (Pulpdent, USA) and Beautifil Flow Plus (Shofu, Japan) were prepared according to ISO 4049 standards. The degree of conversion was assessed using Fourier-transform infrared spectroscopy (FTIR), and microhardness was measured using the Vickers hardness test. A total of 30 discs per material were subjected to both tests, and the results were statistically analysed.
Results: The degree of conversion was significantly higher for Activa Pronto (16.09%) compared to Beautifil Flow Plus (13.81%). Similarly, Activa Pronto demonstrated a significantly greater mean microhardness (34.98 VHN) than Beautifil Flow Plus (23.53 VHN), with $p < 0.001$ for both comparisons.
Conclusion: Activa Pronto exhibits superior polymerization and microhardness compared to Beautifil Flow Plus, suggesting that it is a more durable material suitable for stress-bearing restorations.

## 1. Introduction

Improved mechanical and aesthetic qualities have been the focus of dental restorative material development, especially for direct restoratives utilized in dentistry. While resin-based composites can replicate the structure of teeth so closely, they have become progressively more prevalent (1). The resin matrix, inorganic filler particles, and silane coupling agent are the three primary parts of the resin composite. The initiation system causes the cross-linking reaction to start, converting the carbon-carbon double bonds into carbon-carbon single bonds and forming a polymer. Monomers undergo adequate polymerisation to form a complex polymer network, but partial conversion never happens, leaving certain monomers unreacted (2). In order to start the polymerisation process, resin composites absorb light in the 400–500 nm wavelength range. Free radicals are produced when these monomers react with aliphatic amines after they are activated. "Degree of conversion" describes the percentage of monomers' carbon double bonds that change into single bonds, creating polymer chains in the process (3). Dental composites must have a high monomer to polymer conversion rate in order to be long-lasting. On the other hand, the finished product of dimethacrylate polymers frequently contains a sizable portion of unreacted monomers. The degree of conversion indicates the proportion of polymerizable double bonds that are converted to single bonds (4).

The type of light source, irradiation duration, wavelength, light-tip size, inorganic filler distribution, photo-activation technique, power density, organic matrix composition, and quantity, composite resin colour and photo-initiator type and quantity, are some of the variables that can impact the degree of conversion (DC). The degree of polymerisation during which dental composites are formed has a direct bearing on their mechanical and physical characteristics (5). Reduced conversion leads to restorations with inadequate wear resistance and colour stability, inferior mechanical qualities, and increased sensitivity to discolouration and degradation. The surface microhardness of restorative materials can be compromised by the constant presence of saliva and the forces exerted during mastication. This susceptibility is influenced by the material's cohesive strength and the degree of wear induced by or upon opposing teeth (6). Hardness, defined as a material's resistance to indentation, plays a critical role in determining the structural integrity and longevity of restorations. Notably, the surface hardness of composite resins exhibits a positive correlation with filler content and the extent of polymerization. Beyond aesthetic enhancements, the smooth and durable surfaces of restorations contribute to reduced plaque accumulation (7).

Giomer incorporates surface pre-reacted glass (S-PRG) filler, which consists of an unreacted glass core and a glass-ionomer coating. Key advantages of this filler include the release and recharge of fluoride, strengthening of dental structure, remineralisation of dentin, and prevention of cavities by lowering the release of bacterial acid. Additionally, it strengthens the material's flexural and compressive strengths, which makes it appropriate for restorations that are subjected to stress (8). Activa Pronto is a light-cure, aesthetically pleasing material that was created to replace enamel and dentin. Even in thin regions, its revolutionary rubberized-resin technology (MODULUS) resists wear, chipping, and fracture by absorbing stress. The hydrophilic resin (WETBOND) promotes integration with the tooth structure for a smooth, margin-free fit by improving the diffusion of calcium, phosphate, and fluoride ions. It is a safer option for dental restorations because it is notable for being free of bis-GMA, bisphenol A, and BPA derivatives (9).

This study aims to evaluate the degree of conversion and microhardness of Activa Pronto and Beautifil Flow Plus, contributing to the understanding of their clinical performance and suitability for long-lasting restorations.

## 2. Methodology:

2.1Specimen preparation

In the present in vitro study, samples of Activa Pronto (Pulpdent, USA) and Beautifil flow plus (Shofu, Japan) (Figure 1) composite resins were fabricated in accordance with ISO 4049, the specimens were created using a metallic mould with a central opening that measured 10 mm in diameter and 2 mm in thickness (Figure 2). The metal mould was set up on a glass plate that was 10 mm thick. A mylar strip was placed over the top and base surfaces, and the composite resin was packed in a single step. The composite resin was packed using a mass of 1 kg and a glass sheet that was 1 mm thick. Placing the light guide tip on the upper surface of the composite resin specimens allowed for photo-activation. For 40 seconds, the specimens were exposed to radiation. Following photo-activation, the specimens were taken out of the mould and kept at 37° C in dark, dry containers for 24 hours (Figure 3) (10).


Figure 1. Activa Pronto and Beautifil Flow Plus composite

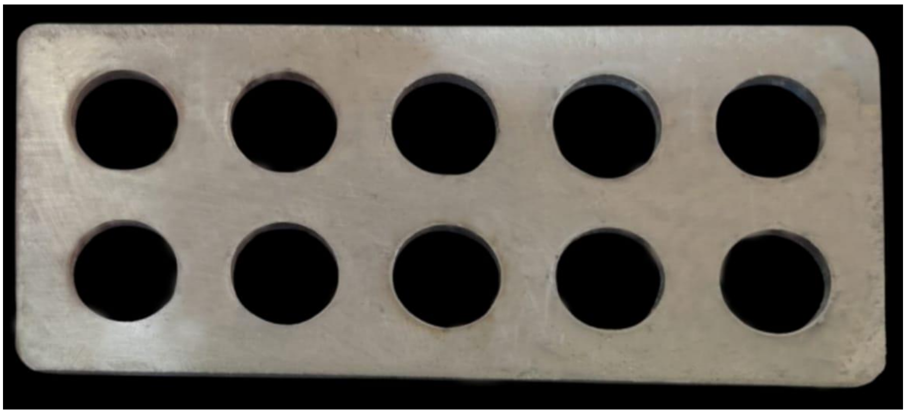

Figure 2. Metallic mould for sample disc preparation.

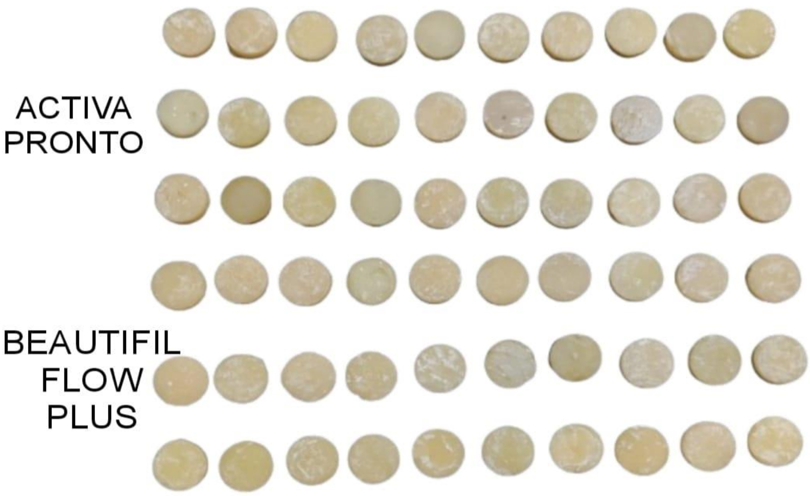


Figure 3. Composite discs

2.2Degree of conversion:

Samples were prepared for Fourier-transform infrared spectroscopy by pressing approximately 0.5 grains of each material between two Mylar sheets under 107 Pa. The resulting discs (1 cm diameter, 0.1 mm thickness) were polymerized for 30 seconds.

For FTIR analysis, both uncured and polymerized samples were incorporated into potassium bromide pellets (1 cm diameter) using spectroscopically pure KBr and a Carver press. FTIR spectra were acquired using a PerkinElmer Model 2000 spectrometer in transmission mode at room temperature. The equivalent aliphatic (1638 cm1)/aromatic (1608 cm1) molar ratios of cured (C) and uncured (U) samples according to the following expression

$$\text{Degree of Conversion (DC) (\%)} = \mathbf{1 - \boldsymbol{C}/\boldsymbol{U} \times 100}$$

2.3Microhardness:

Each group consists of thirty discs for microhardness evaluation (n=30). The Vickers microhardness test was performed on the polished surface of each specimen using a microhardness tester (Shimadzu HMV-G31D, Japan). and a diamond indenter with a pyramidal shape and a square base that was loaded with 200 g for 10 seconds at room temperature (the angle between the opposing faces of the indenter was 136). Five indentations were created in the centre of each specimen, separated by 100 µm. As soon as the diagonals of the indent were measured under the microscope, the Vickers microhardness value was shown on the digital readout of the microhardness tester (11).

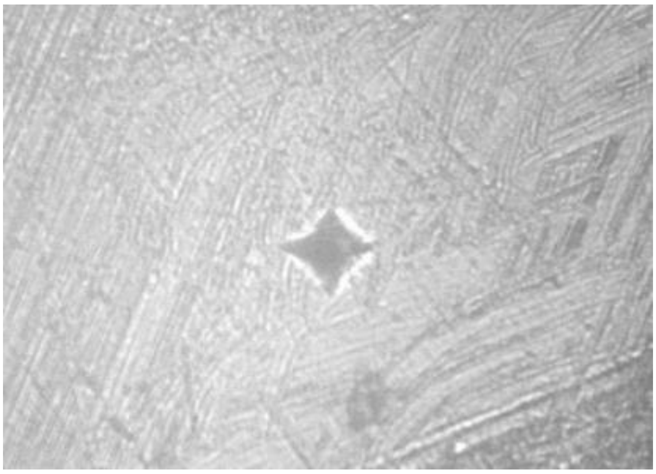

Figure 4. The surface microhardness test indentation by the tester made on the sample is depicted.

## 3. Results

This study compared the degree of conversion (DC) and microhardness of two dental restorative materials: Activa Pronto and Beautifil Flow Plus. The findings of degree of conversion was found to be 16.9% for Activa Pronto and 13.81% for Beautifil Flow Plus (Figure 5 & 6). This indicates that Activa Pronto exhibited a higher degree of polymerization compared to Beautifil Flow Plus. A higher degree of conversion suggests a more complete conversion of monomers into polymers, which correlates with improved mechanical performance and durability of the restorative material. The mean microhardness value of Activa Pronto was 34.98 (measured in Vickers hardness number, VHN), with a standard deviation of 4.111 and for Beautifil Flow Plus, the mean microhardness value was 23.53, with a standard deviation of 2.295. These microhardness values show that Activa Pronto has a significantly higher hardness than Beautifil Flow Plus (Table 1). Higher microhardness indicates better resistance to surface indentation and wear, which is essential for the material's long-term performance in dental restorations. The p-value for both degree of conversion and microhardness between the two materials was 0.000, indicating that the differences observed are statistically significant.

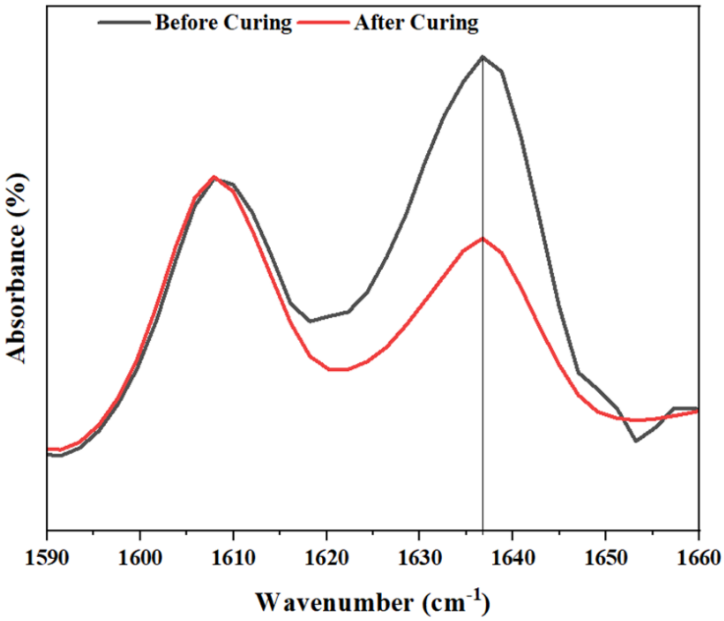


Figure 5. Degree of conversion of Beautifil Flow plus before and after curing.

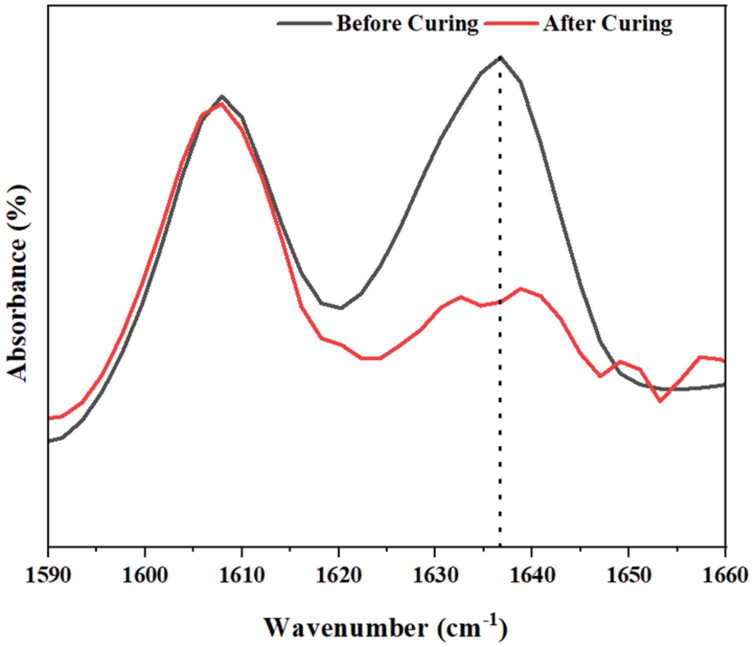


Figure 6. Degree of conversion of Activa Pronto before and after curing.

**Table 1: Comparison of Microhardness between two restorative materials using Independent Sample t test**

| | MATERIAL | N | MEAN | STANDARD DEVIATION | STANDARD ERROR MEAN | P VALUE |
|---|---|---|---|---|---|---|
| MICROHARDNESS | ACTIVA PRONTO | 30 | 34.98 | 4.111 | 0.919 | 0.000 |
| | BEAUTIFIL FLOW PLUS | 30 | 23.53 | 2.295 | 0.513 | |

## 4. Discussion

The study findings indicate that Activa Pronto shows a level of conversion (DC) and microhardness when compared to Beautifil Flow Plus in a significant manner. The increased DC of Activa Pronto, at 16.09% versus Beautifil Flow Plus at 13.81% implies that Activa Pronto undergoes a polymerization process which leads to improved mechanical characteristics such as durability and wear resistance along with a longer lifespan, for the restoration. The polymerization process, in composites can be impacted by factors such as the type of resin matrix used and the distribution of filler particles within the material composition. According to research findings the innovative technology utilized in Activa Pronto seems to facilitate an polymerization compared to traditional methods due to its incorporation of rubberized resin technology resulting in a higher degree of conversion (12).

The results concerning microhardness are of additional importance for the fact that Activa Pronto seems to be a more durable restorative material is reinforced. The mean microhardness value of Activa Pronto at 34.98 VHN far exceeds the value of 23.53 VHN for Beautifil Flow Plus. The improvement in microhardness indicates that Activa Pronto is more inured to indentation and wear, which are vital for the long-term success of restorations in areas under heavy masticatory forces (13). Higher microhardness value also plays the function of the imprinting the surface of the material, which leads to the increase in the performance pointing out more resistance to the surface wear caused by chewing and opposing teeth and also the time keeping the exposed areas clean and whole (14). Activa Pronto's unique formulation, which combines a hydrophilic resin with rubberised resin, may also be responsible for its excellent performance. Better stress absorption made possible by this composition lowers the possibility of chipping or fracture, especially in thinner restoration areas. Additionally, Activa Pronto's hydrophilic resin component improves the material's overall clinical performance by facilitating a smoother, margin-free fit and better integration with the tooth structure (15).

Few study results were contradictory to our findings, study done by Sreevatsan et al evaluated surface microhardness of the Giomer, Compomer, Hybrid Composite and RMGIC using a Vicker's microhardness tester revealed Giomer had more hardness compared to other materials (16) (17). Study by Zavare et al revealed

Giomer and resin-modified glass ionomer groups did not differ significantly in terms of their shear bond strength (18) (19). Study done on Activa bioactive (material from which Activa Pronto was developed after incorporating new technologies) revealed, Activa Bioactive had more rough surface and microporosity compared to Cention N, Equia Forte HT Fil and Fuji II LC groups (20) (21) (22) (23).

However, some contradictory findings in the literature suggest that certain giomer-based materials, like Beautifil Flow Plus, can exhibit comparable microhardness in specific conditions, but overall, Activa Pronto presents as a more robust option for long-lasting restorations.

## 5. Conclusion

According to this study, Activa Pronto performs better than Beautifil Flow Plus in terms of microhardness and conversion degree. According to these findings, Activa Pronto is a better material for restorations that need to be highly resistant to wear and mechanically strong. The results highlight the significance of choosing restorative materials with exceptional polymerisation and hardness properties for long-lasting dental restorations, and they have important clinical ramifications.

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