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# Water sorption of three types of composite resins

**Dr. Linz Ali Shalan.** B.D.S, M.Sc.
**Dr. Samar Abdul Hamed Yasin.** B.D.S, M.Sc.

## Abstract

Silorane low shrink composite resin material introduced with a non-methacrylate resin matrix to realize a fundamental improvement in cure shrinkage, clinical and physical properties. The aim of this study is to measure the water sorption of three type of composite material: Filtek P90, Filtek P60, IPS Empress composites after immersion in deionized distilled water as a function of time.

Thirty disk shape plastic molds (4 mm diameter and 2mm thickness) were constructed to form composite blocks. Teen blocks were made from Filtek P 90 (Silorane) GI, Filtek P 60 (packable) GII and IPS Empress (Nanohybrid) GIII. All specimens were placed in a silica-gel desiccator for 48 hours. The samples were then weighed three times using calibrated electronic microbalance and the average reading was recorded to the nearest 0. 0001g then specimens were kept in individual containers in deionized distilled water at 37 °C. All specimens were periodically weighed. The weight measurements were taken from the second day after incubation and continue as one measurement every week for 6 weeks. Data were subjected to statistical analysis using descriptive analysis, ANOVA and least significant differences LSD test.

Statistical analysis of the results showed that all the specimens continued to gain weight for a period of 4 weeks. After that period the weight gain continued, although at reduced rate. Filtek P90 (Silorane) GI has highly significant less water sorption value ( $p < 0.01$) than the other groups after 6 weeks, while there was no significant differences ( p > 0.٠٥) between IPS Empress (Nanohybrid ) GIII and Filtek P60 ( Packable ) GII in their water sorption value with higher value for GIII.

Silorane which based on siloxane and oxirane resin matrix has less value after 6 weeks followed by Packable composite while IPS Empress has higher value for water sorption. This study concluded that the differences in water sorption capacity of the three composite resin materials are related to the differences in the type of resin matrix, the amount of filler loading and filler particle size.

**Keywords: Water sorption, Sailorane composite, hygroscopic expansion.**

## Introduction

Since the introduction of composite resin materials, one of their major disadvantages was that they undergo a sequence of dimensional changes during & following placement(١).The initial rapid polymerization shrinkage may be sufficient to disrupt the seal between the composite material and the structures to which it is bonded (2).

Water absorption by a material is the amount of water absorbed through the exposed surface and into the body of the material. Once composite resin have polymerized, they are far from stable and will constantly be interacting with their surrounding environment. The principle interaction occurs with water since the restorative materials are continually bathed in saliva and water absorption for some materials is inevitable (3). Water diffuses into matrix causing two opposing phenomena to take place. In some composites, water will leached out free unreacted monomers and ions (4). This outward movement of ions contributes to a further shrinkage and loss in weight of the material. Conversely, hygroscopic absorption of water leads to a swelling of the material and increase in weight (5). This phenomenon may allow for some degree of relaxation of the stresses which are set up within the matrix during polymerization shrinkage (2). Neither the original contraction nor the hygroscopic expansion will be uniform throughout the restoration. Water sorption by composite resin materials is a diffusion-controlled process and the water uptake occurs largely in the resin matrix (3).Water sorption may affect composite resins materials by reducing their mechanical properties and wear resistance.

Efforts have been undertaken to modify the polymerization shrinkage of the restoration. These efforts are related either to the restoration technique or to the development of new materials. A lot of interest has focused on low-shrinking materials development by introducing new filler technology and monomer chemistry (6).

Filtek™ Silorane low shrink resin based composites have been introduced, that uses a non-methacrylate resin matrix to realize a fundamental improvement in cure shrinkage. Filtek™ Silorane resin is based on new Silorane chemistry comprised of ring-opening monomers that provide for low polymerization shrinkage aiming at reducing the polymerization shrinkage (7).

Packable composites, sometimes also called condensable composites, have been introduced to the market with high expectations as an alternative to amalgam, the new packable resin composites have minimal polymerization shrinkage and an increased depth of cure up to 5mm due to the type and size of fillers with higher loading by weight that minimizing light scattering inside the composite resin. Packable composites are claimed for use in stress bearing posterior restorations with improved handling properties, on the basis of the perceived high-filler load, these materials were expected to exhibit superior physical and mechanical properties besides the improvements in handling(8) .

Nanohybrid composites have been produced with nanofiller technology and formulated with nanomers and nanoclusters which combine bigger fillers with isolated nanofiller for filling, the voids between bigger particles and demonstrates lowest polymerization shrinkage with excellent clinical handling characteristics and esthetics (9).

The aim of this study was to determine the water sorption of Filtek P90, Filtek P60 and IPS Empress composite material as a function of time.

## Materials and methods

Thirty disk shaped plastic molds (4mm diameter and 2mm thickness) were constructed to form resin blocks which then divided into 3 groups each of 10 blocks, GI Filtek P90 (Silorane), GII Filtek P60 ( Packable ) and GIII IPS Empress (Nanohybrid ) technical profiles for each material presented in table 1. The composite resin was loaded by injecting it directly from the tube into the hole in order to reduce air voids, the material was condensed into the mold with the aid of plastic instrument (Ash no.6) the surface of the material was covered with a matrix strip and a microscopic glass slide on top of the strip to minimize the oxygen inhibition layer and to obtain the smoothest possible surface. A pressure of (200gm) has been applied for 1min until the slide touched the mold completely to expel the excess material from the mold and to reduce voids (10) and then the weight was removed.

All specimens were polymerized by quartz-tungsten-halogen QTH light cure unit with light intensity 400-450 $MW/cm^2$ for 40 sec. exposure time to top surfaces (6, 7). The distance between the light and the specimen will be standardized by the use of 1mm glass slide centered over the mold (11).Specimens cured under the glass slide had a mirror smooth surface that didn’t require further finishing and polishing(12). Following the curing procedure, the composite specimens were removed from the mold, the excess material was removed from the periphery carefully using a scalpel and care was taken not to touch the surface of the composite resin (6).

All specimens were placed in a silica-gel desiccator for 48 hrs to remove free water as recommended in the standard test for resin-based materials (IS0 4049). Then samples were weighed three times using calibrated electronic microbalance (Sartorius-Germany), the average reading will be recorded to the nearest 0.0001g (1).

The specimens of each group were kept in individual test tubes contain 10 ml deionized distilled water at 37 $^oC$ in incubator (13), the specimens were periodically weighed prior to weighing, the specimens were taken out of water, gently dried with blotting paper and left undisturbed for 4min in order to allow stabilization of each specimen. The weight measurements were taken from the second day (48 hrs) after incubation and continue as one measurement every week for 6 weeks (14). The percentage weight changes were calculated using the following formula:

Weight change=W A-WB\WB X 100%

Where WA is the weight of the sample after immersion and WB is the original weight of the sample before immersion.

## Results

The results of the present study showed that there was an increase in water sorption values after immersion in water for all three tested materials. Table (2) showed the descriptive statistics (mean and standard deviation) of the water sorption values for all tested specimens, Fig (1) shows the differences in mean of water sorption values among groups represented in bar chart graph. Statistical analysis of variance using ANOVA test revealed that there was statistically no significant difference ($P > 0.05$) among tested groups after 1 week while there was high significant differences ( $P < 0.01$ ) among tested groups after 6 week.

Using Least significant differences ( LSD test ) revealed that there is a highly significant differences between GI ( Filtek P=90) and other tested groups II and III, while there was no significant differences between GII ( Filtek P60) and GIII ( IPS Empress).

## Discussion

The results of this study showed wide range of water sorption by the different composite resin materials, all specimens continued to gain weight for a period of 4 weeks, after that period the weight gain continued, although at reduced rate.

There was statistically highly significant differences in water sorption values between GI (Silorane) and other groups (GII and GIII) this is due to the fact that hydrophobic resins of Silorane allow very little hygroscopic expansion and stress relaxation to take place, this result in agree with the finding of (13,18).

GIII (IPS Empress) has higher value for water sorption than that of GII (Filtek P 60) this is due to the facts that the material with lower filler content and higher resin matrix content had higher value of water sorption this result in agree with the finding of (18,10). Also it is manifested that as the filler particles size of composites decreases, the amount of water sorption increases this in agree with the finding of (Maria M. Karabela. *etal*. 2011).

The rate and degree of water sorption and stress relief in composite restoration will be much lower than those found in the in vitro studies, composite resin blocks were allowed to absorb water freely through all surfaces. Composite restorations with a large surface area of resin exposed to the mouth will absorb water more than smaller restorations in which, the resin is confined within two or three tooth surfaces (1).

Weight change in water was evaluated because saliva is a dilute fluid consisting of 99% water. The concentrations of dissolved solids (organic and inorganic) are characterized by wide variations, both between individuals and within a single individual therefore, deionized distilled water was used for a test standard (8).

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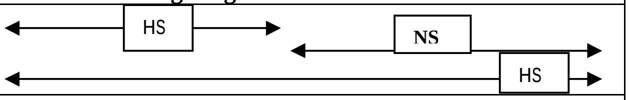
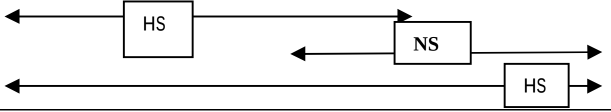
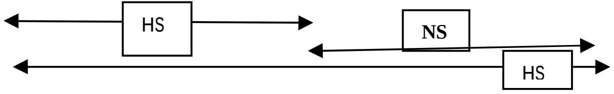
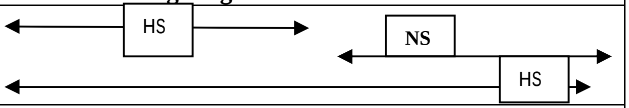
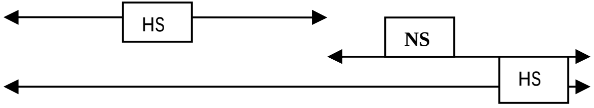
(Table 1): Technical profiles of the composite resins evaluated.

| | **Composite type** | **Filler volume** | **Particle** Size | **Resin system** | **Filler type** | **manufacturer** |
|---|---|---|---|---|---|---|
| IPS Empress | Nano-hybrid | 59 % | 550 nm | dimethacrylate<br>**hydrophilic** | Bariumglass,ytterbium trifluoride,mixedoxide, silicon dioxide and copolymer | Ivoclar vivadent |
| Filtek P60 | packable | 61% | 0.6 um | Bis-GMA<br>UDMA<br>Bis-EMA<br>**hydrophilic** | Zirconia\silica | 3M dental products |
| Filtek P 90 | Silorane | 55% | 0.47 um | Ahybrid made of siloxane and oxirane<br>**hydrophobic** | Quartz,ytterbium fluoride | 3M dental products |

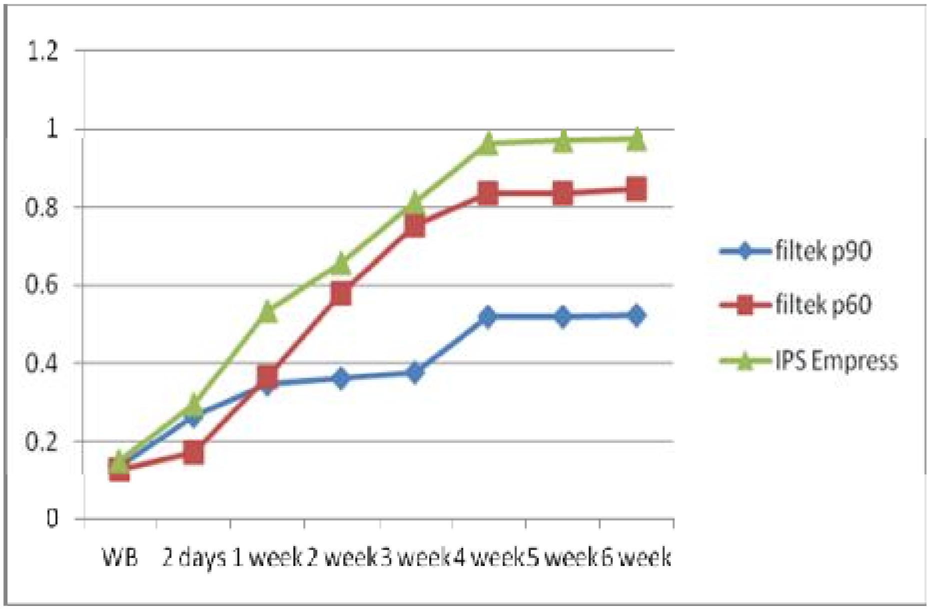
**(Table 2):** Statistical analysis for water sorption values during 6 weeks.

| **Water storage intervals** | **Statistical analysis** | **Filtek P90 G1** | **Filtek P60 G2** | **IPS Empress G3** |
|---|---|---|---|---|
| **2 days** | **Mean** | 0.2640 | 0.1714 | 0.2943 |
| | **SD** | 0.0037 | 0.0077 | 0.0051 |
| **1 Week** | **Mean** | 0.3470 | 0.3646 | 0.5345 |
| | **SD** | 0.0077 | 0.0079 | 0.0055 |
| **2 Weeks** | **Mean** | 0.3640 | 0.5804 | 0.6577 |
| | **SD** | 0.0057 | 0.0048 | 0.0076 |
| **3 Weeks** | **Mean** | 0.3780 | 0.7552 | 0.8138 |
| | **SD** | 0.0038 | 0.0085 | 0.0054 |
| **4 Weeks** | **Mean** | 0.5182 | 0.8372 | 0.9631 |
| | **SD** | 0.0040 | 0.0012 | 0.0063 |
| **5 Weeks** | **Mean** | 0.5200 | 0.8380 | 0.9700 |
| | **SD** | 0.0055 | 0.0080 | 0.0063 |
| **6 Weeks** | **Mean** | 0.5222 | 0.8488 | 0.9750 |
| | **SD** | 0.0046 | 0.0022 | 0.0018 |

(Table 3): one way ANOVA and LSD

| **Water storage intervals** | **Statistical analysis** | **Filtek P90 G1** | **Filtek P60 G2** | **IPS Empress G3** |
|---|---|---|---|---|
| 2 days | ANOVA | * **NS ( P= 0.46)** | | |
| | LSD | | | |
| 1 week | ANOVA | **NS ( P= 0.46)** | | |
| | LSD | | | |
| 2 week | ANOVA | ** **High Significant** | | |
| | LSD |  | | |
| 3 week | ANOVA | **High Significant** | | |
| | LSD |  | | |
| 4 week | ANOVA | **High Significant** | | |
| | LSD |  | | |
| 5 week | ANOVA | **High Significant** | | |
| | LSD |  | | |
| 6 week | ANOVA | **High Significant** | | |
| | LSD |  | | |

*P>0.05
** P<0.01



(Figure 1): mean percentage of weight change over 6 weeks.