The Heliomolar® Family:

Heliomolar®
Heliomolar® Flow
Heliomolar® HB

Scientific Documentation
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1. Introduction

In the last few years, the growing call for invisible restorations and the search for alternative materials to amalgam have led to an increase in the demand for composite materials. In 1984, Ivoclar Vivadent introduced Heliomolar, which has become one of the most widely accepted dental composite materials. In 1994, CRA wrote that Heliomolar was being successfully used all over the world since its introduction in 1984 and even eleven years after its launch it continued to be one of the best composite materials. In April 1999, Heliomolar Flow, a flowable version of Heliomolar, was introduced to cover all the requirements of dentists in terms of indications and application procedures. Furthermore, in December 2000, a condensible product variant called Heliomolar HB was launched, completing the range of Heliomolar materials.

1.1 Heliomolar

Heliomolar falls into the category of inhomogeneous microfilled composites. In dentistry, microfillers are materials whose filler particles are smaller than 1µm. Prepolymers may be added to the microfilled composite to enhance its consistency and physical properties as well as to increase its filler content. The prepolymer used in Heliomolar are microfilled prepolymerized composites that exhibit virtually the same properties as the matrix.

1.2 Heliomolar Flow

Heliomolar Flow is a flowable version of Heliomolar. The monomer content is slightly higher than that of the original Heliomolar to render the material flowable. Because of its flowable consistency, Heliomolar Flow is particularly indicated for Class V defects, mini-cavities of all kinds, preventive resin restorations as well as the repair of composite and ceramic veneers. Furthermore, many dentists use Heliomolar Flow as a first thin increment under Heliomolar or Heliomolar HB restorations because the flowable consistency facilitates adaptation to the cavity bottom and walls.

1.3 Heliomolar HB

Heliomolar HB is the latest member of the Heliomolar family. The adjunct HB stands for Heavy Body. Heliomolar HB falls into the category of what are known as packable or condensible composites. Ivoclar Vivadent offers Heliomolar in three different consistencies to meet the varying requirements placed on the handling properties of composites. Heliomolar HB is particularly suitable for direct restorations in the posterior region.

Two slight alterations of the original Heliomolar were required to obtain the heavy-body consistency of Heliomolar HB. Firstly, the material was rendered less sticky by slightly modifying the proportional composition of the monomer mixture, ie the portion of the comparatively large copolymers was lowered while the portion of microfillers was slightly raised. As a result, the viscosity of the material increased. Secondly, a rheology modifier in the form of an organically modified compound silicate was added to the material. The compound silicate, which contains surface linked, long chain organic groups, increases the firmness of Heliomolar HB but does not compromise the material’s modelling properties.
2. Technical Data

<table>
<thead>
<tr>
<th>Standard composition</th>
<th>Heliomolar</th>
<th>Heliomolar HB</th>
<th>Heliomolar Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bis-GMA, Urethane dimethacrylate</td>
<td>19</td>
<td>18</td>
<td>32</td>
</tr>
<tr>
<td>Decandiol dimethacrylate</td>
<td>3</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Triethylene glycol dimethacrylate</td>
<td>-</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Highly dispersed silicon dioxide, Prepolymer, Ytterbium trifluoride</td>
<td>77</td>
<td>76</td>
<td>59</td>
</tr>
<tr>
<td>Stabilizers, catalysts and pigments</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

(Figures in wt%)
3. Physical Studies

3.1 Abrasion

When Heliomolar was introduced, it set a new standard in terms of resistance to abrasion of composite materials. In 1987, Tani et al published a study, in which Heliomolar's high resistance to abrasion was confirmed. Furthermore, in a study conducted by Leinfelder in 1991, Heliomolar was shown to be one of the materials that exhibited the lowest wear. The experimental of this study included 400,000 cycles of repeated stress and PMMA pellets as the abrasive. While the majority of the composite materials against which Heliomolar was compared in 1987 and 1991 are no longer available, Heliomolar as well as Heliomolar Flow and Heliomolar HB, the two new Heliomolar versions, still rank among the leading composites in terms of resistance to abrasion (Sorensen 2000, Report on file).

Wear of Heliomolar, measured in three independent studies: The results of Tani and Leinfelder are taken from the above-mentioned studies. The results of Sorensen are on file.

<table>
<thead>
<tr>
<th>Material</th>
<th>ΔY</th>
<th>ΔS</th>
<th>ΔK</th>
<th>ΔCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heliomolar</td>
<td>-1.6</td>
<td>-0.02</td>
<td>0.021</td>
<td>0.003</td>
</tr>
<tr>
<td>Herculite</td>
<td>-1.9</td>
<td>0.13</td>
<td>0.043</td>
<td>0.070</td>
</tr>
<tr>
<td>P-30</td>
<td>-9.3</td>
<td>0.07</td>
<td>0.017</td>
<td>0.068</td>
</tr>
<tr>
<td>Bis-Fil II</td>
<td>-2.3</td>
<td>0.04</td>
<td>0.039</td>
<td>0.021</td>
</tr>
<tr>
<td>Estilux Posterior</td>
<td>4.8</td>
<td>0.32</td>
<td>-0.006</td>
<td>0.122</td>
</tr>
<tr>
<td>Distalite</td>
<td>1.6</td>
<td>0.03</td>
<td>-0.14</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Optical stability of Heliomolar

ΔY = Change in the degree of transmission
ΔS = Change in light scattering
ΔK = Change in the absorption coefficient
ΔCR = Change in opacity

3.2 Shade stability

Heliomolar exhibited a high degree of shade stability in trials involving artificial ageing (Powers et al, 1988). With regard to most of the parameters examined, Heliomolar demonstrated the least change when subjected to artificial ageing.
3.3 **Physical data**

<table>
<thead>
<tr>
<th></th>
<th>Compressive strength [N/mm²]</th>
<th>Flexural strength [N/mm²]</th>
<th>Flexural modulus [GPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heliomolar HB</td>
<td>380</td>
<td>114</td>
<td>7.3</td>
</tr>
<tr>
<td>Tetric Ceram HB</td>
<td>338</td>
<td>138</td>
<td>13.2</td>
</tr>
<tr>
<td>P-60</td>
<td>524</td>
<td>170</td>
<td>15</td>
</tr>
<tr>
<td>Solitaire</td>
<td>412</td>
<td>54</td>
<td>3</td>
</tr>
<tr>
<td>Alert</td>
<td>399</td>
<td>119</td>
<td>10</td>
</tr>
<tr>
<td>SureFil</td>
<td>426</td>
<td>131</td>
<td>11</td>
</tr>
<tr>
<td>Prodigy Condense</td>
<td>371</td>
<td>104</td>
<td>8</td>
</tr>
<tr>
<td>Tooth enamel</td>
<td>384</td>
<td>90</td>
<td>84</td>
</tr>
</tbody>
</table>

Munoz (Loma Linda University, California, USA)

3.4 **Fluoride release**

Arends und Ruben (1988) measured the fluoride releasing capabilities of dental composites. Heliomolar was proven to continuously release fluoride for over one year. Moreover, Arends and Zee (1990), who conducted a study using an artificial mouth model, showed that dentin and enamel take up the fluoride released by Heliomolar.

![Fluoride release of Heliomolar (Arends and Ruben 1988)]

3.5 **Polymerization shrinkage**

Among all the composites commercially available, Heliomolar is one of the materials that demonstrates the lowest polymerization shrinkage (Feilzer et al, 1988; Soltez, 2000).

<table>
<thead>
<tr>
<th></th>
<th>Feilzer et al, 1988</th>
<th>Soltez, 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heliomolar</td>
<td>2.2 ± 0.1</td>
<td>1.96 ± 0.07</td>
</tr>
<tr>
<td>Heliomolar HB</td>
<td>2.19 ± 0.10</td>
<td></td>
</tr>
<tr>
<td>Tetric Ceram</td>
<td>2.76 ± 0.05</td>
<td></td>
</tr>
<tr>
<td>Tetric Ceram HB</td>
<td>2.55 ± 0.01</td>
<td></td>
</tr>
<tr>
<td>Esthet X</td>
<td>2.62 ± 0.04</td>
<td></td>
</tr>
<tr>
<td>Point 4</td>
<td>3.01 ± 0.10</td>
<td></td>
</tr>
</tbody>
</table>
Brilliant Lux | 3.5 ± 0.0  
Clearfil Posterior | 4.5 ± 0.5  
Herculite | 3.0 ± 0.2  
P-30 | 2.6 ± 0.3  
Prisma Fil | 3.3 ± 0.2

Polymerization shrinkage in vol %, 1 hour after curing. The data of Soltez (Fraunhofer Institut Werkstoffmechanik, Freiburg, Germany) were measured for Ivoclar Vivadent.

3.6 Marginal adaptation

In a study conducted by Stähle and Ackermann in 1991, 70 percent of the occlusal restorations fabricated of Heliomolar demonstrated tight margins after they were exposed to cyclic loading at 200 N. By contrast, none of the gold inlays, which were inserted using zinc phosphate, exhibited tight margins.

Study on marginal integrity by Stähle and Ackermann (1991)

Depth of dye penetration:
0 = no dye penetration  
1 = dye penetration into the upper half of the restoration  
2 = dye penetration into the lower half of the restoration  
3 = dye penetration down to the cavity floor
4. **Clinical Studies**

4.1 **Heliomolar**

Heliomolar was launched in 1984. Since then, several three- and five-year studies on the material have been accomplished.

3-year studies

Knibbs and Smart (1992) conducted a comparative three-year study with Heliomolar and amalgam. Fifty-two fillings of each material were placed and monitored in terms of marginal adaptation, surface quality, anatomical shape, and proximal antagonist contact. No significant difference in the performance of Heliomolar and amalgam was found; both materials produced favourable clinical results.

Lundin et al (1990) monitored the clinical performance of six different dental composites over three years. The materials, which were placed in Class II cavities, showed very low failure rates. Heliomolar demonstrated the lowest abrasion of all six materials.

Taylor et al (1994) summarized the data of ten clinical three-year studies on the wear of restorative materials. Heliomolar ranked second among the 28 composites examined.

In a clinical three-year study conducted by CRA in the US, Heliomolar produced the best results among the 21 restorations investigated. The following aspects were monitored: abrasion, marginal adaptation, surface quality, antagonist abrasion, resistance to fracture and shade adaptation.

*Clinical Research Associates Newsletter, Volume 18, Issue 5 May 1994: Comparative performance of 21 class 2 materials at 3 years*

5-year studies

In a clinical study conducted by Leinfelder (Mazer and Leinfelder, 1992), 68 Class I and II restorations were placed using Heliomolar. The mean abrasion was as low as 7.7 µm/year. According to Leinfelder, the Heliomolar restorations were characterized by a high degree of shade stability, surface smoothness, resistance to abrasion and acceptance by patients throughout the five years. During the first two years, none of the restorations demonstrated secondary caries. Only two restorations showed signs of incipient secondary caries. Leinfelder attributes the low rate of secondary caries to the fact that Heliomolar releases fluoride ions.

<table>
<thead>
<tr>
<th>Material</th>
<th>Abrasion after 2 years</th>
<th>Secondary caries after 2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heliomolar</td>
<td>12 µm</td>
<td>0 %</td>
</tr>
<tr>
<td>Herculite</td>
<td>30 µm</td>
<td>3 %</td>
</tr>
<tr>
<td>Bisfil-1</td>
<td>42 µm</td>
<td>4.5 %</td>
</tr>
<tr>
<td>P-10</td>
<td>135 µm</td>
<td>2 %</td>
</tr>
</tbody>
</table>

The authors compared the data on abrasion and secondary caries with the corresponding data of other materials. Heliomolar restorations demonstrated the lowest abrasion and were the least prone to developing secondary caries (Mazer and Leinfelder, 1992).

Setcos and Phillips (1995) compared Heliomolar and amalgam in a clinical study on Class I and II restorations. The observation period was five years and the following aspects were monitored: shade stability, marginal discoloration, anatomic shape, marginal integrity, secondary caries, abrasion and sensitivity to temperature. The results prove the favourable clinical performance of Heliomolar.
A CRA Newsletters (1989) summarized the results of clinical trials conducted on 21 different dental composites placed in Class II cavities. In the trials, which lasted between two to five years, the following aspects were monitored: marginal adaptation, proximal contact areas, postoperative sensitivity, secondary caries, surface quality, discoloration and shade. The Heliomolar restorations were attested favourable ratings with regard to all of these aspects. Moreover, Heliomolar demonstrated the lowest abrasion of all the materials tested.

If the results of the 3- and 5-year studies are all added up and a loss analysis according to Kaplan-Meier is conducted, very high survival rates are observed.

<table>
<thead>
<tr>
<th></th>
<th>3-year studies</th>
<th>5-year studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base line</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1 year</td>
<td>99.6 ± 0.4</td>
<td>100%</td>
</tr>
<tr>
<td>2 years</td>
<td>98.0 ± 0.9</td>
<td>100%</td>
</tr>
<tr>
<td>3 years</td>
<td>96.3 ± 1.2</td>
<td>98 ± 1%</td>
</tr>
<tr>
<td>4 years</td>
<td>97 ± 2%</td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>93 ± 2%</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion:** Heliomolar is one of the most proven and clinically successful dental composites on the market.

### 4.2 Heliomolar HB

Clinical studies to examine Heliomolar HB have been initiated. The 12-month results are available.

**Head of study:** Dr Jim R Dunn, D Carlos Munoz  
Loma Linda University, California, USA

**Objective:** Examine the clinical performance of Heliomolar HB

**Experimental:** Fifty Class II cavities were placed in a total of 32 patients, using Heliomolar HB and Excite dentin adhesive. Heliomolar HB was applied in increments. The restorations were examined after six and twelve months. The next follow-up evaluation is due to be conducted 24 months after placement.

**Results:**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1 months</th>
<th>6 months</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restorations evaluated</td>
<td>44</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>Marginal adaptation</td>
<td>100% A</td>
<td>100% A</td>
<td>88% A</td>
</tr>
<tr>
<td>Interproximal anatomical shape</td>
<td>98% A</td>
<td>100% A</td>
<td>95% A</td>
</tr>
<tr>
<td>Post-operative sensitivity</td>
<td>90% A</td>
<td>96% A</td>
<td>91% A</td>
</tr>
<tr>
<td>Secondary caries</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Marginal discoloration</td>
<td>96% A</td>
<td>98% A</td>
<td>88% A</td>
</tr>
<tr>
<td>Proximal contact areas</td>
<td>86% A</td>
<td>96% A</td>
<td>91% A</td>
</tr>
<tr>
<td>Surface polish</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Retention</td>
<td>100 %</td>
<td>100%</td>
<td>98% A</td>
</tr>
</tbody>
</table>
Conclusion: The evaluation conducted six months after placement showed excellent results for Heliomolar HB. After 12 months only one restoration had to be replaced and no other Charlie ratings were observed.

Head of study: Dr Giovanni Dondi dall’Orologio
University of Bologna, Italy

Objective: Examine the clinical performance of Heliomolar HB, placed in Class I and II cavities. Place an initial base layer of Heliomolar Flow in half of all the restorations. After 6 months all patients and after 12 months 62 patients could be evaluated. The next recall is planned after 24 months.

Experimental: Restorations fabricated of Heliomolar HB and Heliomolar Flow/Heliomolar HB were placed in 62 patients according to a split mouth design. Excite was used as the adhesive. Heliomolar HB was placed in increments. The restorations were evaluated after six months. The next follow-up evaluation is due to be conducted at 12 months after placement.

Results:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Baseline</th>
<th>6 months</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal integrity</td>
<td>100% A</td>
<td>100% A</td>
<td>87% A, 13% B</td>
</tr>
<tr>
<td>Discoloration</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Secondary caries</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Surface quality</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Anatomical shape</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Post-operative sensitivity</td>
<td>97% A, 3% B</td>
<td>97% A, 3% B</td>
<td>91% A, 9% B</td>
</tr>
<tr>
<td>Retention</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Baseline</th>
<th>6 months</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal integrity</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Discoloration</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Secondary caries</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Surface quality</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Anatomical shape</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Post-operative sensitivity</td>
<td>98% A, 2% B</td>
<td>98% A, 2% B</td>
<td>100% A</td>
</tr>
<tr>
<td>Retention</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
</tbody>
</table>

Conclusion: The evaluation conducted six months after placement shows favourable results for both kinds of Heliomolar HB restorations, i.e., those placed with Heliomolar Flow and those placed without Heliomolar Flow. The 12 months results confirm the excellent clinical success of Heliomolar HB. The data indicate that in the long term the use of Heliomolar Flow as first thin increment may result in better margins.
5. Toxicology

Heliomolar is applied directly into the cavity. The resin is light-cured in the oral cavity. The following toxicological risks had to be investigated:

- Acute oral risk: patients may accidentally swallow the portion of uncured Heliomolar placed in the cavity
- Local incompatibility with surrounding tissue that comes into contact with the material
- Possible sensitizing reactions
- Peroral long-term risk by eluted low-molecular components
- Mutagenic potential of eluted low-molecular components

5.1 Acute oral toxicity

Tests on the acute oral toxicity of the uncured formulation produced the following values:

<table>
<thead>
<tr>
<th></th>
<th>LD50 (rats) oral p.o.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO filler RO = HELIOMOLAR RO without ytterbium trifluoride</td>
<td>&gt; 5000 mg/kg [2]</td>
</tr>
<tr>
<td>Ytterbium trifluoride</td>
<td>&gt; 5000 mg/kg [3]</td>
</tr>
</tbody>
</table>

5.2 Compatibility with the mucous membrane and local irritation of skin

A primary irritation index of 0.3 was measured in the mucuous membrane. On the basis of this result, the material may be regarded as having a minimally irritating effect in an uncured state [4]. The skin irritation index was also 0.3, indicating a minimal primary irritation effect on skin [5].

5.3 Elution tests

A mutation assay was conducted to assess the effect of oral long-term exposure to possible eluates [6, 7]. Total migration of 230 μg/cm² was measured.

5.4 Ytterbium trifluoride

The toxicity of ytterbium trifluoride in Heliomolar RO is discussed in a comprehensive report by Dr Manfred Herbst [8]. This report reaches the conclusion that ytterbium trifluoride does not involve any health risk if it is used as a component of a polymethacrylate-based filling material.

5.5 Sensitization

Uncured Heliomolar was subjected to a sensitization (maximization) test in guinea pigs. In this rigorous test [9], slight irritation occurred. However, it may be assumed that the cured material has no sensitizing effect.

5.6 Mutagenic properties

Mutation did not occur in an Ames test (reversible mutagenicity assay) under the conditions chosen, neither in the HGPRT genes of V79 cells (Chinese hamster) [10] nor in Salmonella typhimurium strains (TA 1535, TA 1537, TA 1538, TA 98 and TA 100) [11]. Furthermore, in a
chromosome aberration assay conducted on Chinese hamsters, no chromosomal mutations occurred in correlation with Heliomolar [12]. On the basis of these tests, mutagenic effects of Heliomolar are not indicated.

**Conclusion:**

On the basis of the data on hand, an acute or chronic risk for patients is not indicated, if Heliomolar is used properly.

The results of the clinical studies and the general toxicological data on composite materials support the above conclusion.

The chemistry of Heliomolar Flow and Heliomolar HB are similar to that of Heliomolar. The monomer content and the filler composition have only been slightly changed to modify the consistency of the materials.

Thus, the toxicological data on Heliomolar also apply to Heliomolar Flow and Heliomolar HB.

5.7 **Literature on Toxicology**


6. Literature

Arend J, van der Zee Y
*Fluoride uptake in bovine enamel and dentin from fluoride-releasing composite resin*
*Quitessence International* 21 (1990) 541-544

Arends J, Ruben J
*Fluoride release from a composite*
*Quitessence International* 19 (1988) 513-514

Clinical Research Associates
*Comparative performance of 21 class 2 materials at 3 years*
Clinical Research Associates Newsletter, Volume 18, Issue 5 May 1994

Clinical Research Associates
*Restorative resins, new products, one year clinical performance*

Feilzer AJ, De Gee AJ, Davidson CL
*Curing contraction of composites and glass-ionomer cements*
*J Prosthetic Dent* 59 (1988) 297-300

Knibbs PJ, Smart ER
*The clinical performance of a posterior composite resin restorative material, HELIOMOLAR RO: 3-year report*

Leinfelder KF, Mirshahidi M, Cury C, O’Neal W
*An in vitro wear device for determining wear of posterior composites*
*J Dent Res* 70 (1991) 345

Ludin SA, Andersson B, Koch G, Rasmusson CG
*Class II composite resin restorations: A three year clinical study of six different posterior composites*
*Swed Dent J* 14 (1990) 104-115

Mazer R, Leinfelder K
*Evaluating a microfill posterior composite resin - a five year study*

Powers JM, Bakus ER, Goldberg AJ
*In vitro color changes of posterior composites*

Setcos JC
*Heliomolar radiopaque als Amalgamersatz?*
*Phillip J* 12 (1995) 93-95

Staehle HJ, Ackermann J
*Experimentelle Untersuchungen über die Dichtigkeit von okklusalen Kompositfüllungen im Vergleich zu okklusalen Metallinlays*
*ZWR* 100 (1991) 648-653

Tani Y, Goto H, Ida K
*Wear of posterior composite resins*
*Dental materials Journal* 6 (1987) 165-174

Taylor DF, Bayne SC, Leinfelder KF, Davis S, Koch GG
*Pooling of long term clinical data for posterior composites*

Publications on Heliomolar and Heliomolar Flow

Restorative resins, new products, status report
#1 -clinical characteristics
CRA Newsletter 17 (1993) 0

Alternatives for class 3 restorations (results of CRA clinical trial of 21 materials at 3 years)
CRA Newsletter 18 (1994) 1-4

Alhadainy HA, Abdalla AI
*2-year clinical evaluation of dentin bonding systems*

Arends J, Ruben J, Dijkman AG
*The effect of fluoride release from a fluoride-containing composite resin on secondary caries: an in vitro study*
*Quintessence Int* 21 (1990) 671-674

Arends J, Van der Zee Y
*Fluoride uptake in bovine enamel and dentin from a fluoride-releasing composite resin*
*Quintessence Int* 21 (1990) 541-544

Ashe MJ, Tripp GA, Eichmiller FC, George LA, Meiers JC
*Surface roughness of glass-ceramic insert - composite restorations: assessing several polishing techniques*
*J Am Dent Assoc* 127 (1996) 1495-1500

Bayne SC, Heymann HO, Edward J, Swift JR
*Update on dental composite restorations*
*J Am Dent Assoc* 125 (1994) 687-701

Bollen CML, Lambrechts P, Quiryn M
*Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: A review of the literature*
*Dent Mater* 13 (1997) 258-269

Bose M, Ott KHR
*Glättung von (Füllungs-) Werkstoffen, Zahnschmelz und Dentin durch Prophylaxepasten in vitro*
*Dtsch Zahnärzte Z* 50 (1995) 840-843
Bouschlicher MR, Cobb DS, Boyer DB
Radiopacity of compomers, flowable and conventional resin composites for posterior restorations

Bryant RW, Hodge KLV
A clinical evaluation of posterior composite resin restorations
Aust Dent J 39 (1994) 77-81

Bryant RW, Marzbani N, Hodge KLV
Occlusal margin defects around different types of composite resin restorations in posterior teeth
Oper Dent 17 (1992) 215-221

Castline JM, TU SJ
Measured light intensities at simulated dentin/composite bonding interfaces

Christensen GJ
Restorative Dentistry: An update for Practitioners, Educators, Examining Boards

Christensen GJ, Christensen RP
A new technique for the restoration of worn anterior teeth - 1995

Chung K
Effects of finishing and polishing procedures on surface texture of resin composites
Dent Mater 10 (1994) 325-330

Condon JR, Ferracane JL
Assessing the effect of composite formulation on polymerization stress

Condon JR, Ferracane JL
Polymerization contraction stress of commercial composites

Condon JR, Ferracane JL
Evaluation of composite wear with a new multimode oral wear simulator

Davidson CL, Abdalla AI
Effect of thermal and mechanical load cycling on the marginal integrity of Class II resin composite restorations

De Backer J, Dermaut L
Visible light sources and posterior visible light cured resins: a practical mixture
Quintessence Int 17 (1986) 635-641

De Goes MF, Garcia-Godoy F, Cardenas L
Linear and volumetric polymerization shrinkage of the restorative materials

Dietschi D, Ciucchi B, Holz J
A clinical trial of four light curing posterior composite resins: 9-month report

Dietschi D, Holz J
Klinische Untersuchung von vier lichthärtenden Kompositmaterialien für den Seitenzahnbereich - Ergebnisse nach zwei Jahren (1)
Quintessenz 42 (1991) 743-751

Dietschi D, Magne P, Holz J
Recent trends in esthetic restorations for posterior teeth
Quintessence Int 25 (1994) 659-677

Dijkman GEHM, Arends J
Secondary Caries in situ around Fluoride-Releasing Light-Curing Composites: A Quantitative Model Investigation on Four Materials
Caries Res 26 (1992) 351-357

Dijkman GEHM, De Vries J, Lodding A, Arends J
Long-term fluoride release of visible light-activated composites in vitro: a correlation with in situ demineralisation data
Caries Res 27 (1993) 117-123

Donly K, Gomez C
In vitro demineralization-mineralization of enamel caries at restoration margins utilizing fluoride-releasing composite resin
Quintessence Int 25 (1994) 355-358

Fallo GJ, Wakefield CW
Effects of uncontrolled outdoor storage on the polymerization, manipulation, and appearance of visible light-cured composite resin and resin-modified glass ionomer materials
Military Medicine 161 (1996) 290-293

Feilzer AJ, De Gee AJ, Davidson CL
Relaxation of Polymerization Contraction Shear Stress by Hygroscopic Expansion

Feilzer AJ, De Gee AJ, Davidson CL
Curing contraction of composites and glass-ionomer cements
J Prostheth Dent 59 (1988) 297-300

Ferracane JL
Current Trends in Dental Composites

Ferracane JL, Condon JR
Post-cure heat treatments for composites: properties and fractography

Ferracane JL, Mitchem JC, Condon JR, Todd R
Wear and marginal breakdown of composites with various degrees of cure

Franci C, Perdigao J, Cardoso PEC, Meira JBC, Nunes MF
The effect of composite resin, adhesive system, and low-viscosity liner on microleakage

Freilich MA, Goldberg AJ, Gilpatrick RO, Simonsen RJ
Three-year occlusal wear of posterior composite restorations
Dent Mater 8 (1992) 224-228

Frenzel C, Viohl J
Biegefestigkeit von neun Kompositen in Abhängigkeit von verschiedenen Reparaturoberflächen
Dtsch Zahnärztl Z 49 (1994) 729-732

Fujimitsu T, Kato Hitoth K, Wakumoto S
The adaptation of composite to the dentin cavity wall
Dent Mater J 8 (1989) 141-146

Fukushima M, Setcos JC, Phillips RW
Marginal fracture of posterior composite resins
J Am Dent Assoc 117 (1988) 577-583

Fuqua S, Burgess JO, Chan DCN, Nunez A
Recurrent caries in OF restorations in a rodent model

Gogswaardt DC
Die Polymerisationstemperatur lichtvernetzbarer Seitenzahn-Kompositematerialien in Abhängigkeit von der Schichtstärke

Haak R, Noack MJ
Möglichkeiten der Röntgendiagnostik bei Amalgamsatzmaterialien
Quintessence 47 (1996) 1551-1559

Hellwig E, Klimek J, Achenbach K
Auszüge der Schichttechnik auf die Polymerisation von zwei lichthärtenden Komposit-Füllungsmaterialien
Dtsch Zahnärztl Z 46 (1991) 270-273

Herrgott AM, Ziemiecki TL, Dennison JB
An evaluation of different composite resin systems finished with various abrasives

Hibst R, Keller U
Randschluss und Haftfestigkeit von Komposittfüllungen - Präparation und Konditionierung mit dem Er:YAG-Laser
ZWR 104 (1995) 78-83

Hickel R, Kunzelmann KH, Obermeier T
Die Komposittfüllung im Seitenzahnbereich - Teil I & Teil II
ZWR 103 (1994) 610-618

Kanca III J
Maximizing the cure of posterior light-activated resins
Quintessence Int 17 (1986) 25-27

Kanca III J
Visible light-activated composite resins for posterior use - a comparison of surface hardness and uniformity of cure. Update
Quintessence Int 16 (1985) 687-690

Kawai K, Leinfelder K
In vitro evaluation of OCA wear resistance of posterior composites

Knibbs PJ, Smart ER
The clinical performance of a posterior composite resin restorative material, Heliomolar RO: 3-year report

Krejci I, Stergiou G, Lutz F
Einfluss der Nachvergütung auf die Verschleißfestigkeit von Kompositematerialien
Dtsch Zahnärztl Z 46 (1991) 400-406

Lambert D
Closing diastemas, replacing small amalgams using Heliomolar reinforced microfill restoratives
Dental Products Report 0 (2000) 92-93

Leinfelder K
Posterior composite resins: The materials and their clinical performance
J Am Dent Assoc 126 (1995) 663-676

Leinfelder K
Using composite resin as a posterior restorative material

Leinfelder K, Beaudreau RW, Mazer R
An in vitro device for predicting clinical wear

Liebenberg WH
Direct access to equivocal approximal carious lesions
Quintessence Int 27 (1996) 607-617

Lundin SA, Andersson B, Koch G, Rasmusson CG
Class II composite resin restorations: a three-year clinical study of six different posterior composites
Swed Dent J 14 (1990) 105-114

Mair LH
The silver sorption layer in dental composites: three year results

Mair LH
An investigation into the permeability of composite materials using silver nitrate

Mair LH
Subsurface compression fatigue in seven dental composites
Dent Mater 10 (1994) 111-115

Mair LH, Vowles RW
The effect of thermal cycling on the fracture toughness of seven composite restorative materials

Margolis HC, Moreno EC, Murphy BJ
Effect of low levels of fluoride in solution on enamel demineralization in vitro

Mazer R, Leinfelder K
Evaluating a microfill posterior composite resin - a five year study

Mazer R, Leinfelder K, Russell CM
Degradation of microfilled posterior composite
Dent Mater 8 (1992) 185-189

Milosevic A
The influence of surface finish and in-vitro pellicle on contact-angle measurement and surface morphology of three available composite restoratives

Momoi Y, McCabe JF
Hygroscopic expansion of resin based composites during 6 months of water storage
Br Dent J 176 (1994) 91-96

Mount GJ
The tensile strength of the union between various glass ionomer cements and various composite resins

Munksgaard EC, Nolte J, Kristensen K
Adherence of chewing gum to dental restorative materials
Am J Dent 8 (1995) 137-139

NaBadalung DP, Nicholls JI, Brudvik JS
Frictional resistance of removable partial dentures with retrofitted resin composite guide planes
Int J Prosthodont 10 (1997) 116-122

Oden A, Ruyter IE, Oysaed H
Creep and recovery of composites for use in posterior teeth during static and dynamic compression

Palenik CJ, Setcos JC
Antimicrobial abilities of various dentine bonding agents and restorative materials

Papagiannoulis L, Tzoutzas J, Eliades G
Effect of topical fluoride agents on the morphologic characteristics and composition of resin composite restorative materials
J Prosthet Dent 77 (1997) 405-413

Pelka M, Ebert J, Schneider H, Krämer N, Petschelt A
Comparison of two- and three-body wear of glass-ionomers and composites

Pelka M, Frankenberger R, Sindlinger R, Petschelt A
Verschleißsimulation natürlicher Zahn­ harts­substanzen im abrasiven Kontakt
Dtsch Zahnärztl Z 53 (1998) 61-64

Pilo R, Brosh T, Lugassy H, Baharav H, Helt M
The effect of irradiation time on the shear strength of composites
Dent Mater 10 (1994) 338-342

Powers JM, Bakus ER, Goldberg AJ
In vitro color changes of posterior composites

Powers JM, McDowell GC, Lang BR
In vivo wear. Part II: Wear and abrasion of composite restorative materials
J Prosthet Dent 60 (1988) 242-249

Prati C
Early marginal microleakage in class II resin composite restorations

Rasmusson CG, Lundin SA
Class II restorations in six different posterior composite resins: Five-year results.

Rees JS, Jacobsen PH
The polymerization shrinkage of composite resins
Dent Mater 5 (1989) 41-44

Reich E, Schmalz G, Federlin M
Randspaltverhalten von Keramik- und Komposit­inlays in vitro
Dtsch Zahnärztl Z 45 (1990) 656-660

Reinhardt KJ
Der Einfluss der Lichtquelle auf die Randständigkeit von Kompositfüllungen
Dtsch Zahnärztl Z 46 (1991) 132-134

Reinhardt KJ
Der Einfluss des Bonders auf die Randständigkeit und Belastbarkeit von Komposit-Füllungen
Dtsch Zahnärztl Z 47 (1992) 176-178

Retief DH, Mandras RS, Russell CM, Denys FR
Evaluation of the Syntac bonding system
Am J Dent 6 (1993) 17-21

Retief H, Mandras R, Russell CM
Shear bond strength required to prevent microleakage at the dentin/restoration interface
Am J Dent 7 (1994) 43-46

Rzanny A, Göbel R, Welker D
Quasistatische Prüfungen an 21 Füllungs- und Verblendkomposites
ZWR 104 (1995) 698-703
Rzanny A, Welker D
*Rigidity measurements of composite in a methodical comparison*
Quintessenz Zahntech 19 (1993) 1467-1473

Sakaguchi RL, Peters MC, Nelson SR, Douglas WH, Poort HW
*Effects of polymerization contraction in composite restorations*

Saunders WP
*The marginal microleakage of resin-retained bridges in association with existing composite and amalgam restorations*
Dent Mater 6 (1990) 20-23

Scheufele P
*Suitability of different antagonists for pre-clinical in-vitro wear tests*

Setcos JC
*Heliomolar radiopaque as an Amalgamersatz? Eine Fünf-Jahres-Studie von James C. Setcos, Manchester*
Phillip J 12 (1995) 93-95

Shinkai K, Suzuki S, Katoh Y
*Effect of an adhesive bonding system on wear resistance of resin composite restorations*
Quintessence Int 28 (1997) 687-693

Shinkai K, Suzuki S, Leinfelder K, Katoh Y
*How heat treatment and thermal cycling affect wear of composite resin inlays*
J Am Dent Assoc 125 (1994) 1467-1472

Sjörgen G, Hdlund SO, Jonsson C
*A 3-year follow-up study of preformed beta-quartz glass-ceramic insert restorations*
Quintessence Int 31 (2000) 25-31

Staehle HJ, Ackermann J
*Experimentelle Untersuchungen über die Dichtigkeit von okklusalen Komposifüllungen im Vergleich zu okklusalen Metallinlays*
ZWR 100 (1991) 648-653

Steinmetz MJ, Pruhs RJ, Brooks JC, Dhuru VB, Post AC
*Rechargeability of fluoride releasing pit and fissure sealants and restorative composites*

Suliman AA, Boyer DB, Lakes RS
*Cups movement in premolars resulting from composite polymerization shrinkage*
Dent Mater 9 (1993) 6-10

Suliman AA, Boyer DB, Lakes RS
*Interferometric measurements of cusp deformation of teeth restored with composites*

Tani Y, Goto H, Ida K
*Wear of posterior composite resins*
Dent Mater J 6 (1987) 165-174

Taylor DF, Bayne SC, Leinfelder KF, Davis S, Koch GG
*Pooling of long term clinical data for posterior composites*

Tjan AHL, Chan CA
*The polishability of posterior composites*
J Prosthet Dent 61 (1989) 139-146

Turner CW, Meiers JC
*Repair of an aged, contaminated indirect composite resin with a direct, visible-light-cured composite resin*
Oper Dent 18 (1993) 187-194

Versluis A, Douglas WH, Sakaguchi RL
*Thermal expansion coefficient of dental composites measured with strain gauges*
Dent Mater 12 (1996) 290-294

Wassell RW, McCabe JF, Walls AWG
*Wear rates of regular and tempered composites*
J Dent 25 (1997) 49-52

Wassell RW, McCabe JF, Walls AWG
*A two-body friction wear test*

Wassell RW, McCabe JF, Walls AWG
*Subsurface deformation associated with hardness measurements of composites*

Wassell RW, McCabe JF, Walls AWG
*Wear characteristics in a two-body wear test*
Dent Mater 10 (1994) 269-274

Watts DC, Cash AJ
*Analysis of optical transmission by 400-500 nm visible light into aesthetic dental biomaterials*
J Dent 22 (1994) 112-117

*A classification of dental composites according to their morphological and mechanical characteristics*
Dent Mater 8 (1992) 310-319

Willems G, Lambrechts P, Braem MJA, Vuytske-Wauters M, Vanherle G
*The surface roughness of enamel-to enamel areas compared with the intrinsic roughness of dental composites*

Xu X, Burgess Jo, Al-Owyyed, Weathersby
*Artificial caries with fluoride-releasing and non-fluoride-releasing restorative materials*
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