

ExpertiseTM



SCIENTIFIC FACTS



3M ESPE Products in the Focus of International Science

SinfonyTM

76th IADR General Session and Exhibition
Nice, France, June 1998

77th IADR, AADR, CADR General Session and Exhibition
Vancouver, Canada, March 1999

79th AADR/CADR General Session and Exhibition
Chicago, IL, USA, March 2001

80th IADR/BSDR/CED
Cardiff, UK, September, 2002

AAADR/CADR Annual Meeting
San Antonio, TX, USA, March, 2003

81st IADR Meeting
Göteborg, Sweden, June, 2003

82nd IADR Meeting
Honolulu, Hawaii, USA, March, 2004

3M ESPE

Editorial

Dear Reader,

Since several years 3MTM ESPETM SinfonyTM has conquered the dental technician and dentist market as one of the superior modern, light-cured, ultra fine particle veneering composite. 3MTM ESPETM SinfonyTM has convinced our customers by its excellent mechanical properties and aesthetic possibilities as well as its broad range of applications and indications. 3MTM ESPETM SinfonyTM is successfully used as veneering composite for fixed and removable prostheses on metal frameworks, for indirect inlays and onlays, individual crowns, glass fibre reinforced restorations and for the customization of prefabricated teeth. Several in vivo and in vitro studies have been performed at well known universities and scientific institutions by internationally known researches and clinicians underlining the mechanical characteristics and clinical performance of 3MTM ESPETM SinfonyTM.

In this issue we have collected the most important results from in vitro and in vivo studies which have been presented since 1998 on international conferences. Below the original published abstracts of the conference, please find the outcome of the study summarized in the "Aims of the study" and "Results of the study".

We very much hope this Expertise will serve as a valuable source of information and as a basis for further discussion. Please feel free to contact us any time.

Enjoy reading Expertise!

Yours sincerely,



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SinfonyTM

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1. Clinical studies



Fig. 1– 4: Fibre-reinforced inlay bridge veneered with 3MTM ESPETM SinfonyTM Composite. Courtesy of Dr. Luca Ortensi, Bologna



3M™ ESPE™ Sinfony™ 5-year Clinical Performance

Published: Vol. 22, No. 1, January/February 2005

Aim of the Study:

THE DENTAL ADVISOR evaluated 69 restorations after 5 years from 125 restorations, which have been placed initially. In the evaluation after 5 years 52 posterior crowns and 17 inlays/onlays were included.

The following clinical observations were evaluated:

- Resistance to fracture/chipping
- Shade match/esthetics and vitality
- Lack of marginal discoloration
- Wear resistance

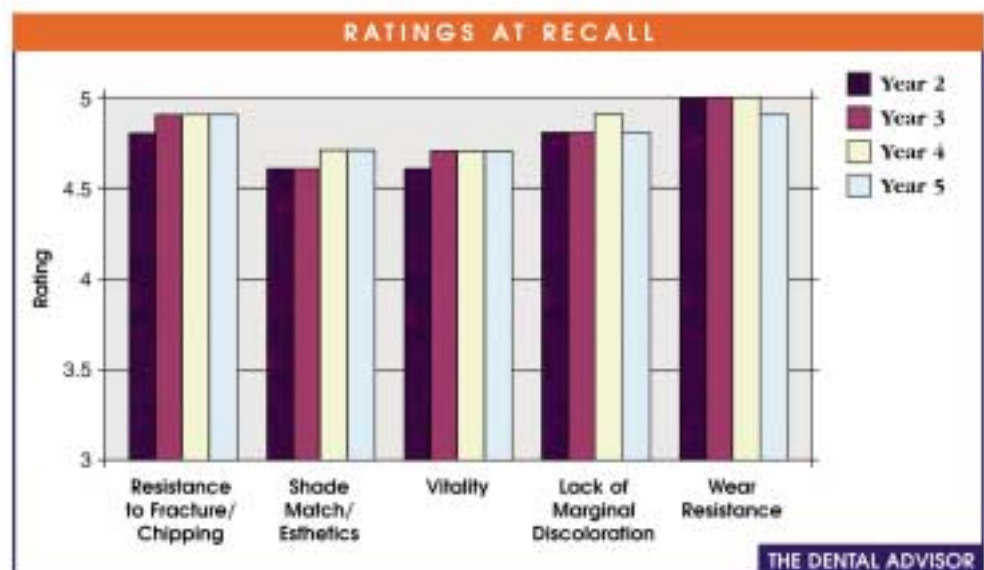
Results of the Study:

THE DENTAL ADVISOR awarded 3M™ ESPE™ Sinfony™ with 4½ + and good ratings in all categories after 5 years (see graph). Moreover after 4 year evaluation it was rated as “Best of 2003 Preferred Product”.

Consultants' Comments:

- Restorations are smooth
- Crowns blend well with surrounding teeth
- An ideal material for inlays
- I will continue to use 3M ESPE Sinfony
- Nice material with very good esthetics at five years

Ratings of THE DENTAL ADVISOR



Resin-Bonded Fiber-Reinforced Composite FPD: Clinical follow-up
P. K. VALLITTU, University of Turku, Institute of Dentistry, Finland

Objectives: Resin-bonded, glass fiber-reinforced composite (FRC) fixed partial dentures (FPD) have been under development. Short-term clinical pilot data has previously been published. The clinical performance of 29 resin bonded FRC FPDs was evaluated in a clinical follow-up survey.

Methods: The FPDs were made to replace 1-3 missing maxillary or mandibular teeth of 29 patients. The FPDs were retained with surface bonding wings, inlays, complete crowns, or their combinations. The FPD had a framework made of continuous unidirectional E-glass fibers with multiphase polymer matrix (Stick, Stick Tech Ltd) and light-polymerized particulate composite resin veneering (Sinfony, 3M ESPE; Vita Zeta LC, Vita) and cemented with resin cement. The FPDs were followed by recall examinations one to three times per year for up to 63 months (mean 42 months). Partial or total de-bonding or the framework fracture was considered a treatment failure.

Results: Two frameworks fractured and three de-bondings occurred. Kaplan-Meier survival probability at 63 months was 75%. Three of the failed FPDs were rebonded in situ resulting functional survival of 93%.

Conclusion: FRC FPD may be considered an alternative for resin-bonded FPDs with metal framework and can be used as multiple-unit restorations combining various retaining elements.

Aim of the Study: Aim of this study was to evaluate the survival rate of glass fiber-reinforced composite (FRC) fixed partial dentures (FPD) in a five years clinical study.

Results of the Study: A resulting in situ survival rate of 93% after five years could be determined.

Clinical trial of Gradia indirect restorations

A. FABIANELLI, S. GRANDINI, E. BERTELLI, and M. FERRARI,
University of Siena, Italy

Objectives: The aim of the study is to evaluate the clinical performances of Gradia (GC Ltd) restorations cemented under clinical conditions and to compare the results with those obtained using 2 competitor products.

Materials and Methods: Fifty patients were selected and received an indirect restoration after giving an informed written consent. All cervical margins were placed 1 mm below the cemento-enamel junction (CEJ). The sample teeth were divided in four groups. Group 1: 15 Gradia inlays luted with Linkmax (GC); Group 2: 15 Gradia crowns luted with Fuji Plus 'translucent' (GC); Group 3: 10 Targis (Ivoclar) crowns luted with Linkmax (as control); Group 4: 10 Sinfony (3MESPE) crowns luted with Fuji Plus (as control). Bonding and luting materials were applied strictly following manufacturers' instructions. The following clinical parameters were evaluated in double blind: 1. Postoperative sensitivity, 2. Marginal leakage, 3. Marginal integrity, 4. Color stability, 5. Surface staining, 6. Retention, 7. Surface crazing (Micro-cracks). The patients were evaluated clinically at baseline, 1 week, 1, 6 and 12 months.

Results: Group 1 samples showed only an endodontic failure. Group 2 samples showed a debonding of a restoration that was rebonded and it is still in place. In Group 3, one sample showed post-op sensitivity after 12 months. No clinical problems were found in Group 4. All the other scores of 1-4 group samples were clinically acceptable. Statistical analysis showed no differences among the four groups of samples.

Conclusions: The 12-month clinical data showed that Gradia indirect restorations perform similarly to competitors. Longer clinical data will clarify the clinical behavior of Gradia.

Aim of the Study: Within this clinical study the performance of 3M™ ESPE™ Sinfony™ crowns was compared to competitor products.

Results of the Study: In contrast to the indirect restorations made of competitor materials there was no clinical problems evident for 3M™ ESPE™ Sinfony™ crowns during the observation period of 1 year.

2. Mechanical properties

- Specimens (Flexural strength, compressive strength, Youngs Modulus etc.)
- Fibre reinforced composite restorations (Fracture strength etc.)
 - Crowns
 - Bridges
- Bond strength to metal
- Bond strength to fibre reinforced materials
- Bond strength to resin cements

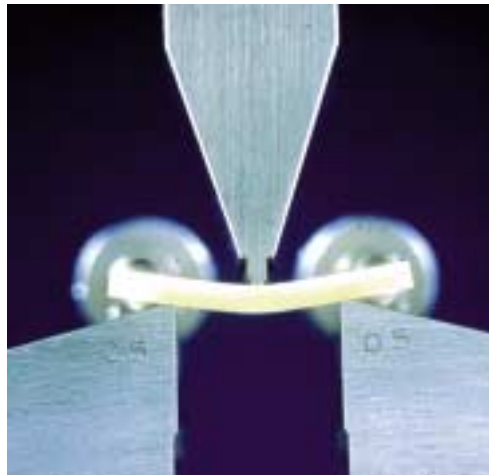


Fig. 5: Flexural strength measurement of specimens

5.



Fig. 6: Fracture strength measurement of copings

6.

3025

Effects of Accelerated Ageing and Thermocycling on the Flexural Strength of Indirect Resin Composites

D. NATHANSON, and M. GHULMAN, Boston University, MA, USA

Objectives: To evaluate in-vitro the effect of ageing and thermocycling on the flexural strength of new indirect resin composites.

Methods: Four indirect resins: Gradia (GC), Sculpture (Pentron), Sinfony (3M ESPE), Tescera (BISCO), and one direct resin composite Z100 (3M ESPE) as a control were tested. Resin bars (2 x 2 x 25 mm) were prepared (n = 10 per group) and stored in distilled water at 37°C for 24 hours, then aged for 1, 3, or 8 weeks at 60°C, or thermocycled for 500, 1000 or 2000 cycles at 5°–55°C. Non-thermocycled and non-aged samples were used as control. A three-point bend test was conducted in an Instron testing machine. One-way ANOVA statistics followed by Tukey tests were performed.

Results: FS data (MPa) is shown in the table below:

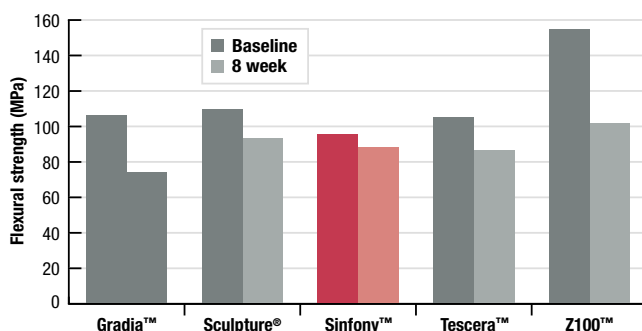
Material	Baseline	Accelerated Ageing, FS			Thermocycling, FS		
		1 week	3 weeks	8 weeks	500 cycl.	1000 cycl.	2000 cycl.
Gradia	106.23	89.84	78.66	74.37	87.12	84.84	83.56
Sculpture	109.66	105.96	103.53	93.03	108.22	106.05	100.18
Sinfony	95.78	94.09	90.13	88.13	98.33	94.47	94.93
Tescera	105.26	102.84	101.92	86.74	101.6	94.91	88.33
Z100	154.61	113.77	110.45	101.94	115.62	113.12	90.91

Conclusions: The 8 week accelerated ageing and 2000 thermocycles significantly decreased the flexural strength of all resin composites tested except Sinfony. The indirect resins showed less decrease in FS than the direct resin, indicating better resistance to ageing, although FS values for the direct resin were relatively high.

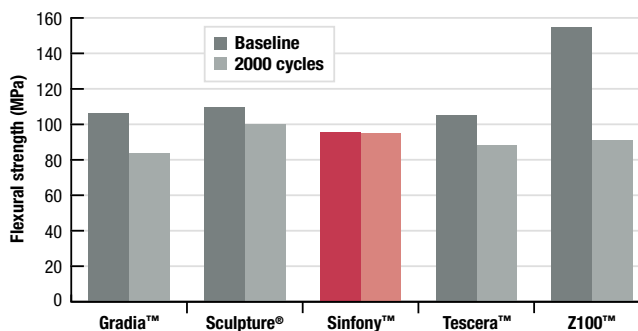
Aim of the Study: This study evaluated the effect of accelerated ageing and thermocycling on the flexural strength of the indirect resin composites Gradia™ (GC®), Sculpture® (Pentron®), 3M™ ESPE™ Sinfony™, Tescera™ (Bisco™) and one direct resin composite 3M™ ESPE™ Z100™ as control.

Results of the Study: 3M™ ESPE™ Sinfony™ shows a very high flexural strength even after accelerated ageing and thermocycling. Only 3M™ ESPE™ Sinfony™ does not show any significant decrease of the flexural strength over 8 weeks accelerated ageing and after 2000 thermocycles.

Accelerated Ageing (60° C)



Thermocycling (5°–50° C)



Properties of Advanced Laboratory Composites

C. TRAJTENBERG, M. ELDIWANY, D. LI, J. M. POWERS, Houston Biomaterials Research Center, UT-Houston Dental Branch, Houston, Texas, USA

Compressive strength and modulus, flexural strength and modulus, and color stability of advanced laboratory composites (dentin shade – Arglass, AG; Sculpture, SC; Sinfony, SF; Targis, TG) were measured. Polymerization systems were: AG-Unixs, SC-Cure Lite Plus, SF-Visio α , β , TG-Targis Quick/Targis Power. Flexural properties were measured following ISO 4049. Color changes (ΔE^*) after aging for 450 kJ/m² in a Weather-Ometer and after staining for 7 days in cranberry juice were measured on a spectrophotometer using CIE L*a*b*. Means (n = 5), standard deviations and Tukey-Kramer intervals (TI, p = 0.05) of properties are listed.

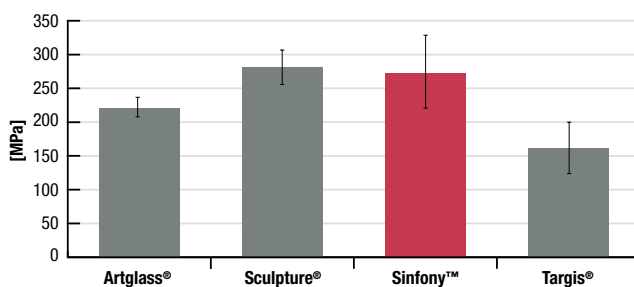
Product	AG	SC	SF	TG	TI
Comp strength, MPa	221 (12)	281 (24)	272 (54)	162 (37)	62
Comp modulus, GPa	5.8 (0.4)	5.8 (0.4)	3.3 (1.2)	5.1 (0.4)	1.2
Flex strength, MPa	87 (10)	83 (22)	105 (8)	96 (10)	ns
Flex modulus, GPa	6.3 (0.4)	8.6 (0.6)	4.7 (0.4)	6.7 (0.7)	1.0
ΔE^* , aging 450 kJ/m ²	1.5 (0.3)	1.2 (0.5)	1.1 (0.2)	2.3 (0.8)	0.9
ΔE^* , cranberry juice	2.2 (1.7)	3.0 (0.4)	2.3 (0.4)	2.4 (1.5)	ns

Analysis of variance showed significant differences among the composites, except for flexural strength and staining in cranberry juice. Composite SC was more rigid in bending. Composite SF was notably more flexible in both compression and bending. None of the composites had perceptible color changes ($\Delta E^* < 3.3$) after accelerated aging or staining. Supported by 3M ESPE™ AG and Jeneric/Pentron.

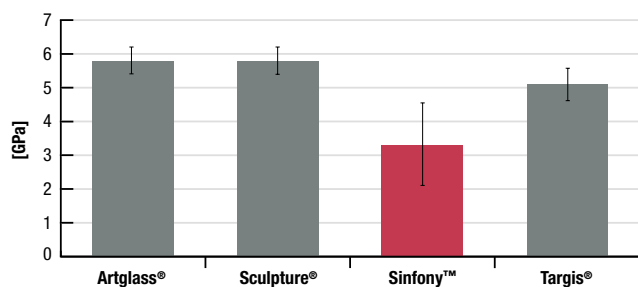
Aim of the Study: Comparison of the mechanical properties of four modern crown & bridge veneering composites.

Results of the Study: 3M™ ESPE™ Sinfony™ showed a very interesting combination of material properties with a high flexural strength and low elasticity modulus. 3M™ ESPE™ Sinfony™ is therefore a very flexible composite in both compression and bending and hence a very promising hybrid composite for the veneering of removable prosthetics.

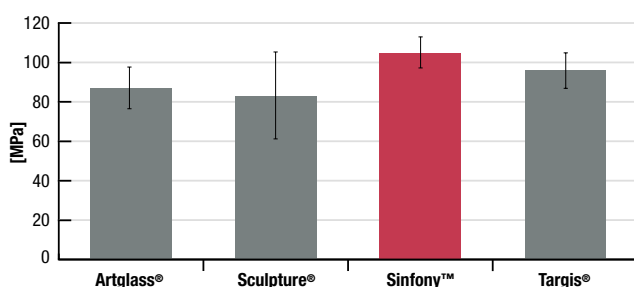
Compressive strength



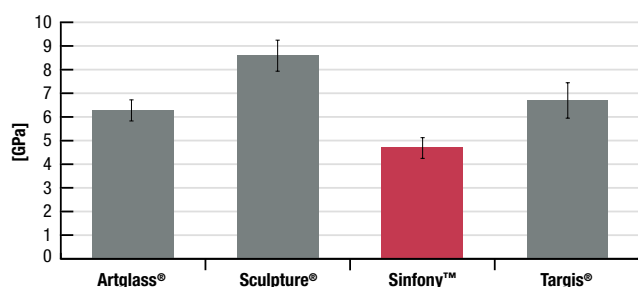
Compressive modulus



Flexural strength



E-Modulus



3142

Fracture Resistance of Polymer Crowns – Effects of Fibre-Reinforcement and StressF. LEHMANN¹, G. EICKEMEYER¹, and P. RAMMELSBURG², ¹ University of Munich, Germany, ² University of Heidelberg, Germany

Objectives: This in-vitro study should investigate the influence of cementation technique, thermal cycling (ThC), fatigue and fibre-reinforcement on the fracture resistance of metal free polymer crowns.

Methods: Ninety-six caries free human third molars underwent standardized tooth preparation with a chamfer finishing line of 0.5 mm. After impression taking one half of the crowns was manufactured with Sinfony™ (3M ESPE, Germany) and the other half was made with a Vectris® fibre core (Ivoclar, Liechtenstein) which was veneered with Sinfony. The crowns were cemented either with GIC (Ketac cem®, 3M ESPE) or resin cement (Compolute®, 3M ESPE). One third of the tooth-crown units underwent 10,000 thermal cycles between 5°C and 55°C. The second third was additionally loaded with 1,200,000 cycles of 50 N, whereas the last third was not physically stressed. The sample size of each experimental group was 8. All crowns were axially loaded to failure with a crosshead speed of 0.5 mm/min.

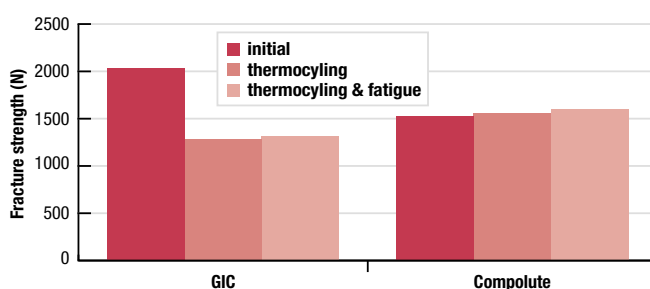
Results: ThC resulted in a significant reduction of the mean fracture strength from 2037 N to 1282 N for Sinfony crowns cemented with GIC (U-test: $p = 0.005$), whereas additional fatigue showed no further effects (1316 N). For Sinfony crowns cemented with Compolute physical stress had no influence on the fracture resistance (no ThC: 1532 N, ThC: 1559 N, ThC+fatigue: 1606 N). Fibre-reinforcement of the Sinfony crowns resulted in higher mean fracture loads up to 2800 N. However, the effect of the fibre core was not statistically significant because of a increased variation (700 N–4500 N). Cementation technique and physical stress demonstrated no effect on the stability of Sinfony-Vectris crowns (GIC/Compolute; no ThC: 2692 N/2797 N; ThC: 2097 N/2113 N; ThC+fatigue: 2046 N/2208 N). However, 50% of all crowns cemented with GIC were loosened after thermal cycling.

Conclusions: Sinfony and Sinfony-veneered Vectris crowns offer acceptable fracture resistance for posterior region, however adhesive cementation with resin cement should be preferred.

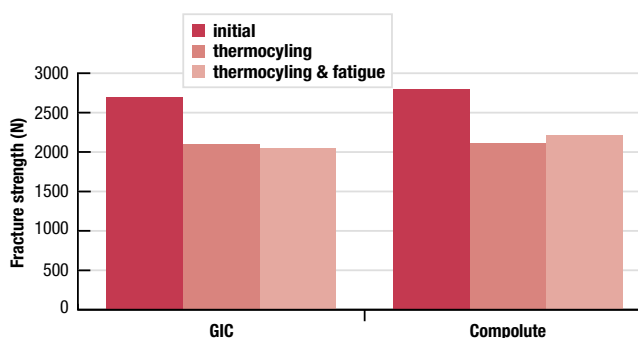
Aim of the Study: This in-vitro study investigated the influence of cementation technique, thermal cycling (ThC), fatigue and fibre-reinforcement on the fracture resistance of metal free 3M™ ESPE™ Sinfony™ polymer crowns.

Results of the Study: 3M™ ESPE™ Sinfony™ crowns with and without fibre-reinforcement offer high fracture resistance for the posterior region. Adhesive cementation with resin cement should however be preferred.

Sinfony™



Sinfony™ – Vectris®



Fracture Strength of Fibre Reinforced Composite Crowns

T. KURETZKY*; M. SALEX and B. GANGNUS, 3M ESPE AG, 82229 Seefeld, Germany

1487

Recently a new generation of crown and bridge veneering resins containing submicron glass fillers was introduced. These ultrasmall particle hybrid composite materials distinguish themselves, compared with conventional microfill C & B resins, through improved mechanical properties. It is claimed that these composites are suitable for metal free crowns and even bridges using fibre reinforcement. However, there is a scarcity of data comparing these metal free restorations with conventional metal based restorations. To determine the performance of the new C & B resins, standardized crowns were prepared and stored over night in 36°C water. Fracture strength was then determined before (n = 5) and after thermocycling (TC = 10.000 cycles between 5°C and 55°C) (n = 7). The crowns were fixed in an alignment apparatus and loaded under an 45° angle until fracture. The following groups were tested: Sinfony (1) (3M ESPE) reinforced with either Fibrekor® (Jeneric Pentron) (S/F) or Vectris Single® (2) (Ivoclar) (S/V), Targis® (Ivoclar) reinforced with 2 and as control group Degulor M® alloy (Degussa) veneered with 1 using the Rocatec® (3M ESPE) metal bonding system (S/D). Table: mean values in (N) and standard deviation in parenthesis:

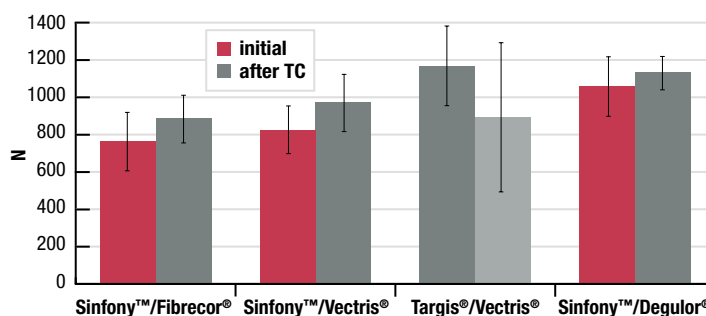
(N)	Sinfony TM /Fibrekor®	Sinfony TM /Vectris®	Targis®/Vectris®	Sinfony TM /Degulor®
Initial	762 (± 157)	823 (± 122)	1167 (± 213)	1058 (± 158)
After TC	889 (± 122)	970 (± 144)	890 (± 390)	1135 (± 78)

From ANOVA statistically significant differences between the means were found at the 95,0% confidence level with $p < 0.05$. The multiple range test showed that initially T/V was not statistically significant different from control, whereas the other groups showed lower fracture strength than control. After TC only S/V was not statistically different from control. TC did not cause a statistically significant decrease in fracture strength for groups S/F, S/V, S/D, whereas for group T/V a statistically decrease in fracture strength was observed. The data indicate that the new composite fibre reinforced crown and bridge veneering materials should be suitable for manufacturing metal free crowns.

Aim of the Study: The aim of the study was the evaluation of the fracture strength of fibre reinforced composite crowns initially and after thermocycling (eg. SinfonyTM).

Conclusion: SinfonyTM shows sufficient fracture strength initially and after thermocycling for the construction of metal free fibre reinforced crowns.

Fracture strength before and after thermocycling (TC)



2014

Fracture Resistance of Four-unit Composite Bridges with and without Fibre Reinforcement

K. SCHULZ, L. BORCHERS, and M. STIESCH-SCHOLZ, Medizinische Hochschule Hannover, Germany

Objectives: The aim of this in-vitro study was to investigate the influence of fibre-reinforcement on fracture resistance of four-unit composite bridges.

Methods: In the plastic model of an upper jaw the teeth 24 and 27 underwent a chamfer type preparation and were duplicated using polyurethane-based resin. The roots of the duplicated teeth were covered with an artificial silicone periodontium and embedded in polyurethane, thus creating a base for the construction and testing of four-unit bridges. Ten bridges each were fabricated of three composites [Sinfony – SIN (3M ESPE), Vita Zeta – VIT (Vita Zahnfabrik), Targis – TAR (Ivoclar-Vivadent)] without reinforcement (control) and ten bridges each were produced with fibre-reinforcement [everStick – EVS (Stick Tech)]. Additionally, VIT was reinforced with Stick (STI; Stick Tech, Fin) and Targis was reinforced with Vectris (VEC; Ivoclar-Vivadent). After thermocycling in water (10,000 cycles, 5°C/55°C), all bridges were fixed to the polyurethane base with temporary zinc oxide eugenol cement and loaded until failure in a universal testing instrument (type 20 K, UTS) at a crosshead speed of 1 mm / min. Data were analyzed using ANOVA and post-hoc Tamhane-T2 tests ($p < 0.05$).

Results: Means and standard deviations of loads at failure (F) are listed in the table. Super-script letters indicate homogenous subsets without statistically significant differences (uppercase: columns, lowercase: rows). Fibre-reinforced bridges showed an increase of load at failure by at least a factor of two as compared with the control group.

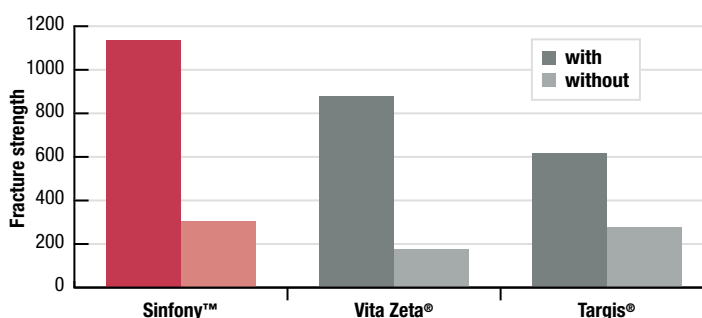
	Control F [N]	EVS F [N]	STI F [N]	VEC F [N]
SIN	306.72 ± 41.33 ^A	1136.50 ± 165.25		
VIT	177.50 ± 42.15	878.24 ± 157.23 ^{B, a}	800.76 ± 273.13 ^a	
TAR	276.42 ± 83.37 ^A	615.36 ± 331.47 ^B		1191.42 ± 189.51

Conclusions: Fibre-reinforcement significantly improves fracture resistance of four-unit composite bridges ($p < 0.05$).

Aim of the Study: This study evaluated the influence of fibre reinforcement on the fracture resistance of four-unit composite bridges

Results of the Study: Fibre reinforcement significantly improves fracture resistance of four-unit composite bridges. Moreover, the combination of 3M™ ESPE™ Sinfony™ and everStick® showed the highest fracture resistance.

4-unit bridges out of composite with and without fibre reinforcement



Resin-Metal Bond: new Resins and Bonding Systems using Silanization

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Germany

929

Acrylic veneers are still commonly used. They are especially useful in removable partial dentures retained by telescope crowns because of the flexibility of the resins that is needed due to the inevitable minor deformation of the metallic framework. The weak point remains the resin-metal interface. Therefore it was the aim of this study to compare the bond strength of the classic Dentacolor (Heraeus/Kulzer) system to new combinations of resins and bonding systems using silanization including the Cojet (3M ESPE) repair system for the dental office. Specimen of three different alloys were cast (Maingold [M], HeraGG [H] and Albalbond E [A]; Heraeus/Kulzer) and bonded to different resin/opaquer combinations (Artglass standard & flow, Dentacolor; Heraeus/Kulzer and Sinfony standard & Cojet; 3M ESPE) using the silanization methods recommended by the manufacturer (Siloc; Heraeus/Kulzer, Rocatec and Cojet; 3M ESPE). A total of 30 specimens were fabricated for each combination, divided into three groups and tested under dry and wet (dwell time: 3 days [3d] and 2 months [2m] conditions. The clinically relevant three-point flexure test (similar to ISO EN 9693) was used to determine the fracture strength on a Zwick 1454 universal testing machine. Data were analyzed using a multivariate analysis of variance (Manova). The following table displays the results for the best and the worst resin/alloy/storage combination:

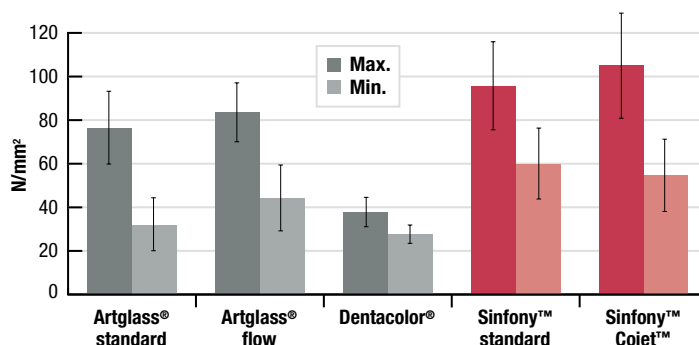
N/mm ²	Artglass standard	Artglass flow	Dentacolor
Max.	76.32 ± 16.41 [A/2m]	83.76 ± 13.78 [A/dry]	37.94 ± 7.65 [A/2m]
Min.	32.07 ± 11.78 [H/3d]	44.19 ± 15.09 [M/3d]	27.76 ± 3.90 [H/dry]
N/mm ²	Sinfony standard	Sinfony Cojet	
Max.	95.69 ± 20.22 [A/dry]	105.12 ± 23.98 [A/dry]	
Min.	60.08 ± 15.71 [H/dry]	55.03 ± 16.54 [H/2m]	

The new resins and bonding-systems produced significantly higher ($p < 0.05$) bond strength values as compared to the classic Dentacolor system. Within the limits of this study it can therefore be concluded that general improvements have been made in the resin-metal bond. The best combination was found to be the Cojet repair system for the dental office. Further studies are needed to evaluate the clinical long-term success rate.

Aim of the Study: The bond strength of new resin-metal bonding systems were compared on different alloys and under different storage conditions.

Results of the Study: 3MTM ESPETM SinfonyTM showed the best bond strengths in a three-point flexure test after CojetTM treatment.

Fracture strength



Bond Strength of New Crown and Bridge Composites to Different Metals

O. LOEFFEL*, H. LÜTHY and P. SCHÄRER, University of Zurich, Center for Dental and Oral Medicine, Zurich, Switzerland

The aim of this study was to evaluate the bond strength of unalloyed titanium (Ti) and of a high gold alloy (Au) to the following C & B composites: Targis (TA), Artglass (AG), Vita Zeta LC (VZ), Solidex (SO), Columbus (CO), and Sinfony (SI) before and after thermocycling (TC). Tensile test specimens were prepared by bonding the composites between pairs of cast disks (d: 8 mm) of the same metal. A specially designed alignment allowed to orientate the disk faces absolutely parallel and to select a constant composite thickness of 1.5 mm. For each metal-composite combination groups of 10 specimens were prepared. Prior to bonding, all metal surfaces were polished first, and then either sandblasted (S) or treated with Rocatec (R) according to the manufacturers instructions. One half of each group was additionally subjected to TC (104) in water (5°/55°) during 333 h. All test assemblies were placed in a universal testing machine and loaded until failure (crosshead speed: 2 mm/min). The results were analyzed with ANOVA ($p < 0.001$). Mean strength values in MPa (SD) were:

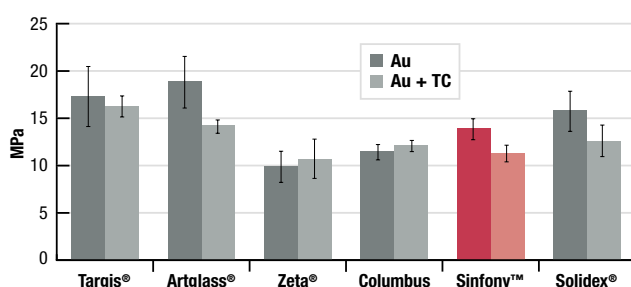
Composites	Au	Au + TC	Ti	Ti + TC
TA (S)	17.3 (3)	16.3 (0.8)	20.2 (1.2)	19.4 (2.3)
AG (S)	18.9 (2.6)	14.2 (0.6)	18.8 (2)	13.4 (1.6)
VZ (S)	9.9 (1.2)	10.7 (1.6)	12.2 (2.3)	12.4 (1.8)
CO (S)	11.5 (0.7)	12.1 (0.5)	19.4 (1)	15.2 (0.4)
SI (R)	13.9 (1)	11.3 (0.9)	22.1 (1.6)	18.5 (1.1)
SO (R)	15.8 (2)	12.6 (1.6)	21.6 (1.4)	13.4 (1.6)

After thermocycling, Targis, Sinfony and Columbus showed a significantly higher bond strength to titanium than to gold alloy. For the other composites no difference was observed.

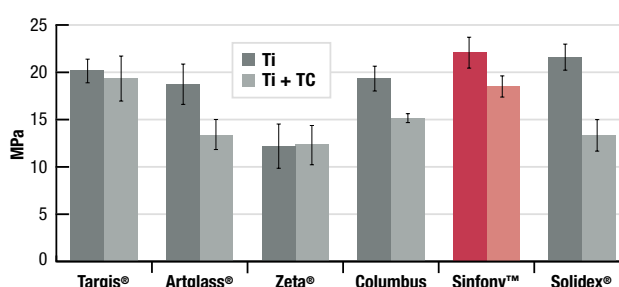
Aim of the Study: Evaluation of the bond strength of modern crown and bridge veneering materials to gold and titanium before and after thermocycling.

Results of the Study: After thermocycling 3M™ ESPE™ Sinfony™ showed significantly higher bond strength to titanium than to gold alloy.

Tensile bond strength before and after Thermocycling (TC)



Tensile bond strength before and after Thermocycling (TC)



Shear Bond Strength of Composite on Fiberreinforced FPD Material

T. FRAUENHOLZ, M. ROSENTRITT, M. BEHR, R. LANG, G. HANDEL, Department of Prosthetic Dentistry, University of Regensburg, Germany

1486

The aim of the study was to determine the shear bond strength (SBS) of laboratory veneering and chair side filling composites on the new fiberglass reinforced (FRC) FPD composite Vectris. The SBS was determined on new material and on aged material to simulate FPD repair. Specimens (20 x 10 x 2 mm) were produced using the FRC framework material (Vectris Frame, Ivoclar, FL), following the manufacturers instructions 280 basic supports, 140 aged (for 6 months storage) and 140 new (24 h after manufacture), were air abraded (Al₂O₃, 2 bar), and the surface of the samples was silanised (Wetting Agent, Ivoclar, FL). Specimens (ø = 5 mm, h = 3 mm) from 1) Targis (control) (Ivoclar, FL), 2) Sinfony (3M ESPE, G), 3) Artglass (Kulzer, G), 4) Tetric Ceram (Vivadent, FL), 5) Dentacolor (Kunzler, G), 6) Z 100 (3M, USA), 7) Spectrum (Dentsply, G) were polymerized onto these basic supports with the help of a stainless steel mould using the corresponding curing device. The SBS was examined on 10 samples in each series after 24 h storage in water and after thermal loading (TCL) (6000 cycles 5°C/55°C, each 2 min.) using a universal test machine (Zwick, G, initial speed: v = 1 mm/min.). Medians and 25%/75% percentiles were calculated. Statistics were performed using Mann Whitnex U-test (a = 0.05)

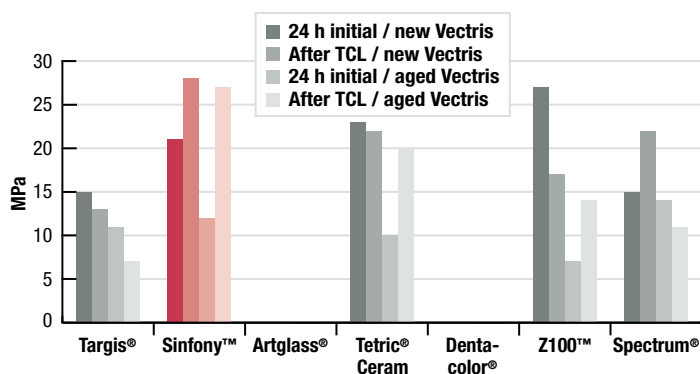
SBS (MPa)	Vectris®	Targis®	Sinfony™	Art-glass®	Tetric Ceram®	Denta-color®	Z100™	Spectrum®
24 h initial	New	15	21	0	23	0	27	15
After TCL	New	13	28	0	22	0	17	22
24 h initial	Aged	11	12	0	10	0	7	14
After TCL	Aged	7	27	0	20	0	14	11

Artglass and Dentacolor showed no adhesion to the Vectris samples. SBS on aged Vectris material was worse compared to new material. Sinfony, Tetric Ceram and Spectrum showed high SBS on all materials, on aged material the initial BS was just acceptable. In the case of fracture of FPD Tetric Ceram and Spectrum could be used for in-vivo veneering and repairing of aged and new materials. Z100 only on new FPD. Sinfony could be used for laboratory veneering of fiberreinforced material

Aim of the Study: Determination of shear bond strength of composites (incl. 3MTM ESPETM SinfonyTM) on fibre reinforced FPD material. Repairing of a new and aged Vectris[®] material was simulated via in vitro shear tests.

Results of the Study: 3MTM ESPETM SinfonyTM is suitable for repairing – also on aged samples, whereas Artglass[®] and Dentacolor[®] showed no adhesion at all.

Shear bond strength after 24 hours water storage of thermocycling (TC)



0240

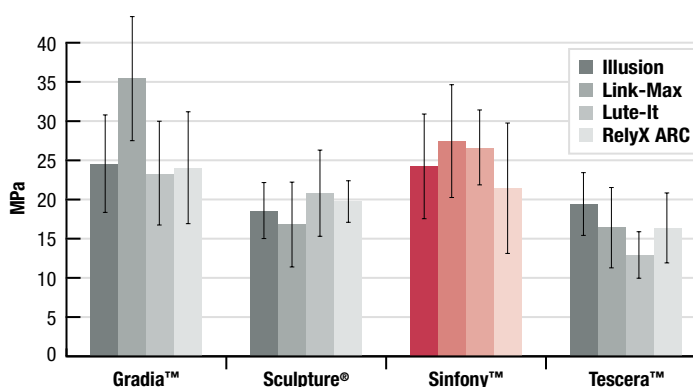
Bond Strength of Resin Cements to Indirect Composite Resins

M. GHULMAN, N. ASHAYERI, and D. NATHANSON, Boston University, MA, USA

Objectives: To evaluate the bond between resin cements and indirect resins.**Methods:** The study included 4 indirect resins: a. Gradia (GC), b. Sculpture (Pentron), c. Sinfony (3M ESPE), and d. Tescera (BISCO), and 4 resin cements: 1. Illusion (BISCO), 2. Link-Max (GC), 3. Lute-It (Pentron), and 4. Rely-X ARC (3M ESPE) with their respective adhesive systems. 160 round indirect resin samples (10 x 2 mm) were prepared. Cylindrical-shaped resin cement samples (2.3 x 3 mm) were formed by positioning a split mold over the indirect resin sample. Shear bond strength was tested, using an Instron testing machine.

	Gradia™	Sculpture®	Sinfony™	Tescera™
Illusion	24.51 (6.36) ^A	18.49 (3.47) ^A	24.23 (6.56) ^A	19.39 (3.98) ^A
Link-Max	35.5 (8.13) ^B	16.8 (5.2) ^A	27.45 (7.02) ^A	16.46 (5.29) ^{AB}
Lute-It	23.28 (6.63) ^A	20.8 (5.57) ^A	26.58 (4.76) ^A	12.89 (2.93) ^B
RelyX ARC	24.01 (7.34) ^A	19.81 (2.04) ^A	21.42 (8.17) ^A	16.39 (4.35) ^{AB}

* Superscript letters represent statistically equivalent means within each indirect resin.

Results: Bond strength of cements to indirect resins ranged from 12.89 (2.93) to 35.5 (8.13) MPa. Overall, significantly higher bond strengths were found for Gradia and Sinfony indirect resins ($p = .027$). Link-Max had a significantly higher bond strength to Gradia than all other cements ($p = .001$). Illusion had a significant higher bond to Tescera than Lute-It ($p = .015$).**Conclusions:** All cement systems tested produced adequate bond strengths, but certain cement-resin combinations exhibited significantly higher bond strengths.**Aim of the Study:** The shear bond strength of composite luting materials is examined intensively. This study has focused on the bond strength of adhesive luting materials to different indirect composites.**Results of the Study:** Significantly higher shear bond strengths were found for 3M™ ESPE™ Sinfony™ and Gradia™ indirect resins.**Bond Strength of Resin Cements to Indirect Composite Resins**

3. Wear

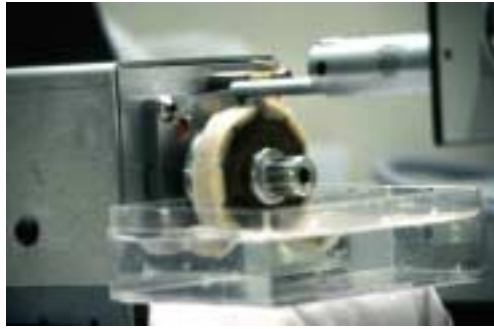


Fig. 7: Wear testing machine

Chemical and Mechanical Degradation of Dental Composites

N. KOURNETAS, L. SCHEIDELER, and J. GEIS-GERSTORFER,
University of Tuebingen, Germany

Objectives: In vitro wear studies should simulate the oral environment as close as possible. The purpose of this study was to evaluate the wear behavior of three materials after chemical stress and mechanical loading.

Methods: 12 cylindrical specimens from each of the following materials were manufactured: Artglass (Heraeus Kulzer, Germany), Sinfony (3M ESPE, Germany), Arabesk (Voco, Germany). The specimens were polished after one day storage in distilled water at 37°C. Profilometric analysis was performed (Perthometer 3D, Mahr, Germany). Four specimens of each material were incubated in water, 0, 1N NaOH, and in enzymatic solution of horse serum Pseudocholinesterase (PCE, 50 mu/ml), respectively, at 37°C. After 3 months, the samples were subjected to impact loading in a chewing simulator (Willytec, Germany, 49N, 1.6 Hz) for a period (1.2 x106 cycles) that simulates 5 years of clinical function.

Results: Mean (SD). The results were compared by t-test (p = 0.05).

		Solution								
		Wear Depth [µm]			Volume Loss [mm³]			Surf. Roughn. Ra [µm]		
		Water	NaOH	PCE	Water	NaOH	PCE	Water	NaOH	PCE
Material	Artglass	81.3 ^a (5.6)	229.3 ^b (70.63)	210.1 ^b (31.6)	0.3 ^c (0.1)	1.1 ^d (0.3)	1.1 ^d (0.2)	0.6 ^e (0.1)	1.3 ^f (0.5)	1.5 ^f (0.1)
	Sinfony	102.2 ^g (32.3)	120 ^g (39.1)	175 ^h (32.2)	0.3 ⁱ (0.1)	0.5 ⁱ (0.1)	0.9 ⁱ (0.3)	0.8 ^k (0.3)	1.1 ^k (0.4)	1.5 ^l (0.1)
	Arabesk	111.7 ^m (51.3)	192.7 ^m (81.4)	267.1 ⁿ (60)	0.5 ^o (0.3)	0.9 ^o (0.6)	1.5 ^p (0.6)	0.6 ^q (0.3)	1.4 ^r (0.6)	1.4 ^r (0.4)

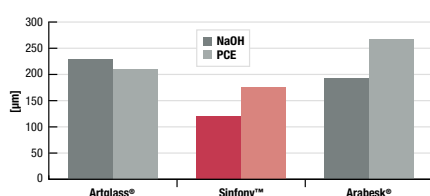
Mean values with same superscript letter are not statistically significantly different at the p = 0.05 level.

Conclusions: Incubation in PCE resulted in a statistically significant enhancement of wear and roughness values in comparison to water for every material tested. Enzymatic degradation was sometimes even more pronounced than alkaline deterioration. This raises questions about the integral chemical stability of these materials when they are applied in the enzymatically active oral cavity.

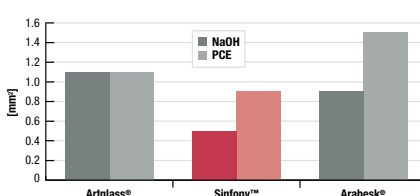
Aim of the Study: This study evaluated the wear behavior of 3M™ ESPE™ Sinfony™, Artglass® (Heraeus Kulzer®) and Arabesk® (Voco®) after chemical stress (NaOH or PCE) and mechanical loading in a chewing simulator.

Results of the Study: Wear depth and Volume loss were lower for 3M™ ESPE™ Sinfony™ than for other materials. For the surface roughness the results were statistically similar in all three groups.

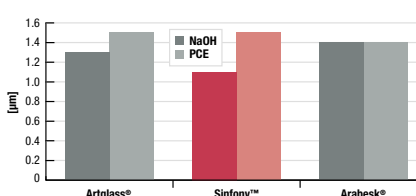
Wear Depth



Volume Loss



Surface Roughness Ra



In vitro wear behavior of facing composites

M. ROSENTRITT*, M. BEHR, M. SÖLDNER, G. HANDEL, Department of Prosthetic Dentistry, University of Regensburg, Germany

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The aim of this study was to compare and rank the wear resistance of facing composites after aging in an artificial oral environment (AOE) and after three-body abrasion testing (TBT). Samples were made of the materials Artglass, Dentacolor (both Heraeus, G), Sinfony, an experimental formulation (both 3M ESPE, G), Columbus (Centres Mateaux, F) and Thermoresin (GC, J) according to the manufactures instructions. The samples were fixed to a ball bearing slope surface (45°) in the AOE to simulate mastication and sliding movement (100.000 cycles 1 Hz/20 N; antagonists: Steatite, d = 6 mm, 250x5°C/55°C each 2 min., H₂O). As a reference bovine enamel was investigated. Three-body testing was performed (Willytec, G; 100.000 cycles: samples 130 U/min, antagonist 60 U/min, force 15N) using millet sheet/rice food bolus. The wear trace after AOE and TBT was measured in comparison to the non-worn surface (Perthometer S6P, Mahr-Feinprüf, G). Statistics: Mann-Whitney-U- and Kruskal-Wallis-test (a = 0.05).

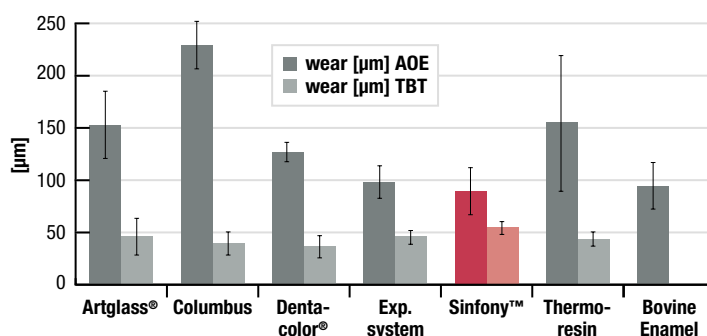
Mean ± std.	Artglass®	Columbus	Dentacolor®	Exp. system	Sinfony TM	Thermoresin	bovine enamel
wear [µm] AOE	153 ± 30	229 ± 22	127 ± 7	98 ± 13	89 ± 22	155 ± 65	94 ± 26
wear [µm] TBT	46 ± 13	40 ± 10	37 ± 9	46 ± 6	55 ± 5	44 ± 5	—

After AOE the exp. System, Sinfony and bovine enamel showed significant lower wear than the other materials. After TBT highest wear resistance could be determined for Dentacolor and Columbus. Significant differences in wear behavior between AOE and TBT could be found.

Aim of the Study: The aim of this in vitro study was to compare and rank the wear resistance of indirect composites after aging in an artificial oral environment and after three-body abrasion testing (TBT).

Results of the Study: After aging in an artificial oral environment 3MTM ESPETM SinfonyTM showed significant lower wear compared to the other materials.

Wear after AOE & TBT



4. Color stability



In vitro colour stability of restorative materials after UV-irradiation

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University of Regensburg, Germany

0278

Objectives: The aim of this in-vitro study was to determine the discolouration of ten restorative materials after UV-irradiation.

Methods: Eight cylindrical specimens (d = 6 mm, h = 5 mm) of each material were fabricated according to the manufacturers instructions (Elipar Trilight, 3M Espe, G, 2 x 40 sec.). The tested materials were CeramX, Dyract AP, Dyract Extra, Esthet X, Spectrum TPH (Dentsply DeTrey, G), Filtek Z250, Sinfony (3M Espe, G), Tetric Ceram (Ivoclar-Vivadent, FL), Miris (Coltene-Whaledent, USA) and Venus (Heraeus-Kulzer, G). The discolourations were measured using the reflection spectrometer Minolta CM 3500d (Minolta, J) according to the CIE-L*a*b*-System (DIN 6174). Data were obtained after 24 h, 48 h and 72 h of UV-irradiation with Xenotest CPS+ (Xenotest, D) (DIN 53387) in comparison to the non-irradiated specimens. The colour difference ΔE^* was calculated using the colour values L*, a* and b*. Medians and 25%/75% percentiles were statistically analysed using the Mann-Whitney- U-Test (p = 0.05).

Results:

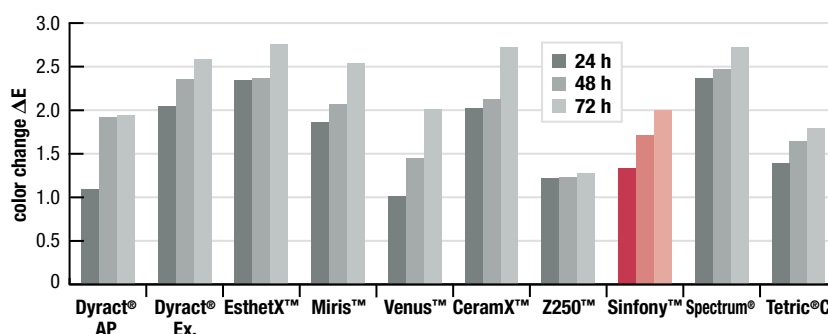
ΔE /Mat.	Dyract AP [®]	Dyract Ex. [®]	EsthetX TM	Miris TM	Venus TM
24 h	1.09	2.05	2.34	1.86	1.01
48 h	1.92	2.36	2.37	2.07	1.45
72 h	1.94	2.59	2.76	2.54	2.01
ΔE /Mat.	CeramX TM	Z250 TM	Sinfony TM	Spektrum [®]	Tetric [®] C
24 h	2.02	1.22	1.33	2.37	1.39
48 h	2.13	1.23	1.71	2.47	1.65
72 h	2.72	1.28	2.00	2.72	1.80

Conclusions: After 72 h exposition, the colour stability of Filtek Z250, Dyract AP, Sinfony, Tetric Ceram and Venus was significantly higher compared to the other materials.

Aim of the Study: The aim of the study was to measure the colour stability of different restorative materials.

Results of the Study: 3MTM ESPETM SinfonyTM showed a very high colour stability compared to competitive materials.

Discoloration of different composite materials



3026

Effect of Accelerated Ageing on Color Stability of Indirect Resin Composites

M. GHULMAN, and D. NATHANSON, Boston University, MA, USA

Objectives: To evaluate the effect of accelerated ageing on color stability of new indirect resin composites.

Materials and Methods: Four indirect resin composites: Gradia (GC), Sculpture (Pentron), Sinfony (3M ESPE), Tescera (Bisco), and one direct resin composite Z100 (3M ESPE) as a control, were tested. Resin disks 15 in diameter and 2mm in thickness were prepared (n = 10 per group) then aged in distilled water at 60°C for 1, 3, 8, 12 or 18 weeks. A non-aged group was used as baseline. Changes in color vs. ageing time were recorded and ANOVA statistics followed by Tukey tests were performed.

Results: Are shown in calculated mean ΔE^* per observation period:

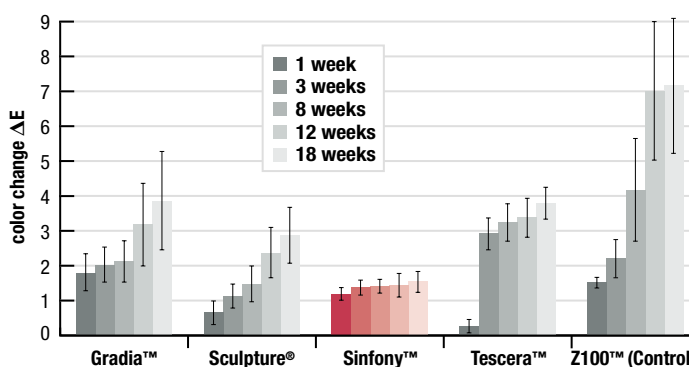
Material	ΔE^* (SD)				
	1 week	3 weeks	8 weeks	12 weeks	18 weeks
Gradia	1.79 (0.49)	2.03 (0.49)	2.12 (0.58)	3.19 (1.21)	3.86 (1.44)
Sculpture	0.66 (0.27)	1.14 (0.34)	1.48 (0.51)	2.37 (0.72)	2.89 (0.72)
Sinfony	1.2 (0.15)	1.38 (0.21)	1.42 (0.17)	1.45 (0.30)	1.55 (0.26)
Tescera	0.28 (0.21)	2.93 (0.42)	3.26 (0.46)	3.4 (0.48)	3.8 (0.45)
Z100 (Control)	1.53 (0.12)	2.23 (0.54)	4.17 (1.38)	7.01 (1.98)	7.17 (1.93)

Conclusions: Accelerated ageing caused a significant color change in all resin composites tested. All indirect resins had ΔE^* less than 4 over the entire test period. The direct resin had a $\Delta E^* = 4.17$ at 8 weeks, and reached $\Delta E^* = 7.17$ at 18 weeks. Sinfony exhibits a significantly lower color change over the entire period of the study. There was no significant color change for any material between the 12 and 18 weeks observations.

Aim of the Study: This study evaluated the effect of accelerated ageing on color stability of the indirect resin composites Gradia™ (GC®), Sculpture® (Pentron®), 3M™ ESPE™ Sinfony™, Tescera™ (Bisco™) and one direct resin composite 3M™ ESPE™ Z100™ as control.

Results of the Study: 3M™ ESPE™ Sinfony™ exhibits a significantly lower color change over the entire period of the study.

Color stability depending on accelerated aging



Properties of Advanced Laboratory Composites

C. TRAJTENBERG, M. ELDIWANY, D. LI, J. M. POWERS, Houston Biomaterials Research Center, UT-Houston Dental Branch, Houston, Texas, USA

Compressive strength and modulus, flexural strength and modulus, and color stability of advanced laboratory composites (dentin shade – Arglass, AG; Sculpture, SC; Sinfony, SF; Targis, TG) were measured. Polymerization systems were: AG-Unixs, SC-Cure Lite Plus, SF-Visio α , β , TG-Targis Quick/Targis Power. Flexural properties were measured following ISO 4049. Color changes (ΔE^*) after aging for 450 kJ/m² in a Weather-Ometer and after staining for 7 days in cranberry juice were measured on a spectrophotometer using CIE L*a*b*. Means (n = 5), standard deviations and Tukey-Kramer intervals (TI, p = 0.05) of properties are listed.

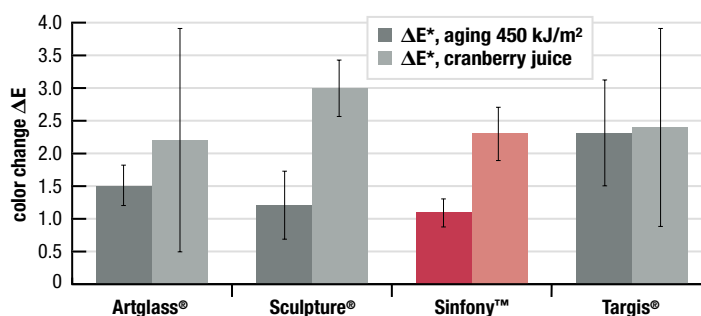
Product	AG	SC	SF	TG	TI
Comp. strength, MPa	221 (12)	281 (24)	272 (54)	162 (37)	62
Comp. modulus, GPa	5.8 (0.4)	5.8 (0.4)	3.3 (1.2)	5.1 (0.4)	1.2
Flex. strength, MPa	87 (10)	83 (22)	105 (8)	96 (10)	Ns
Flex. modulus, GPa	6.3 (0.4)	8.6 (0.6)	4.7 (0.4)	6.7 (0.7)	1.0
ΔE^* , aging 450 kJ/m ²	1.5 (0.3)	1.2 (0.5)	1.1 (0.2)	2.3 (0.8)	0.9
ΔE^* , cranberry juice	2.2 (1.7)	3.0 (0.4)	2.3 (0.4)	2.4 (1.5)	ns

Analysis of variance showed significant differences among the composites, except for flexural strength and staining in cranberry juice. Composite SC was more rigid in bending. Composite SF was notably more flexible in both compression and bending. None of the composites had perceptible color changes ($\Delta E^* < 3.3$) after accelerated aging or staining. Supported by 3M ESPE™ AG and Jeneric/Pentron.

Aim of the Study: Comparison of the color changes of four modern crowns & bridge veneering composites.

Results of the Study: 3M™ ESPE™ Sinfony™ showed very low color changes.

Color stability after different treatments



5. Bacterial adhesion

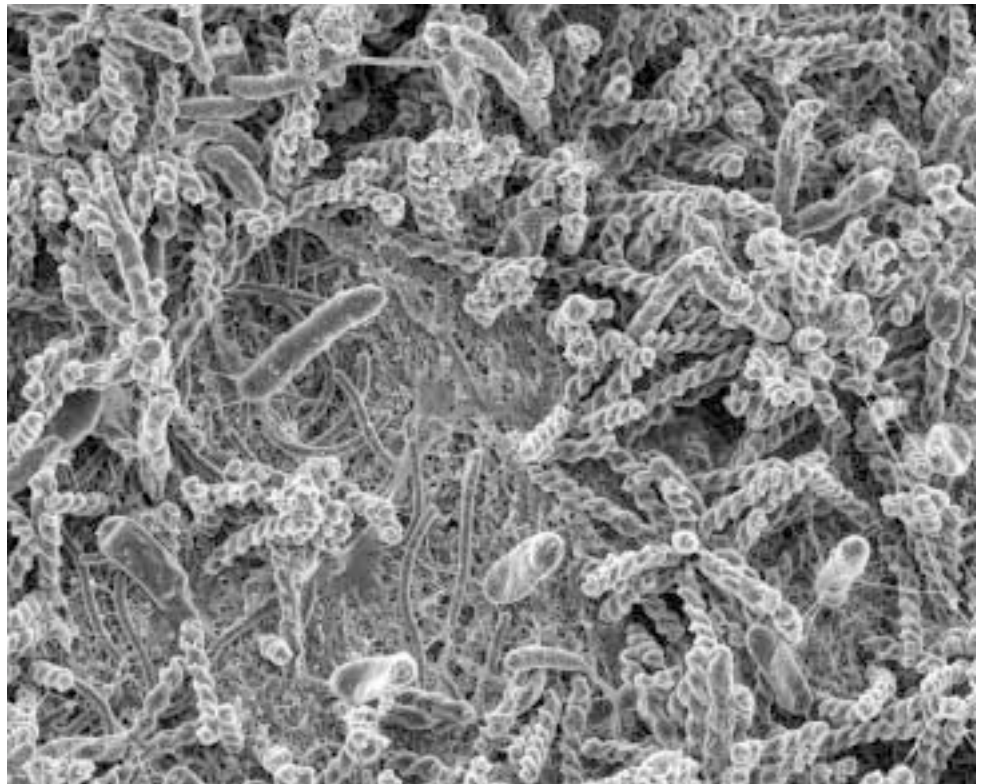


Fig. 8: SEM picture of bacterial adhesion on dentin

In vitro Adherence of Pellicle and Bacteria to Dental Materials

G. GRÖGER, M. ROSENTRITT, M. BEHR, M. MEDLHAMMER, and G. HANDEL,
University of Regensburg, Germany

0708

Objectives: The purpose of this study was to rank the adherence of the oral bacteria *Streptococcus mutans* to dental materials without (w/o) and with (w/) a pellicle.

Methods: Eight samples were made according to the manufacturers instructions (diameter 10 mm, thickness 2 mm) of each of the following materials: the facing composites Signum (Heraeus-Kulzer, G) and Sinfony (3M ESPE, G), the facing ceramics Ducera (Degussa, G) and Lava Ceram (3M ESPE, G), the alloy Dentitan (Krupp, G) and the metal titanium (Dentaurum, G). Human enamel slabs served as controls. The samples were incubated with *S. mutans* ATCC 25175 at 37°C for 150 min with and without a salivary pellicle. Images were obtained using a scanning electron microscope (Stereoscan 240, Cambridge Instr., G) and the relative area covered by bacteria determined with the image analysis program Optimas 6.2 (Media Cybernetics, USA). Medians and 25%/75%-percentiles were calculated. Statistics: Mann-Whitney U-test ($p < 0.05$).

Results:

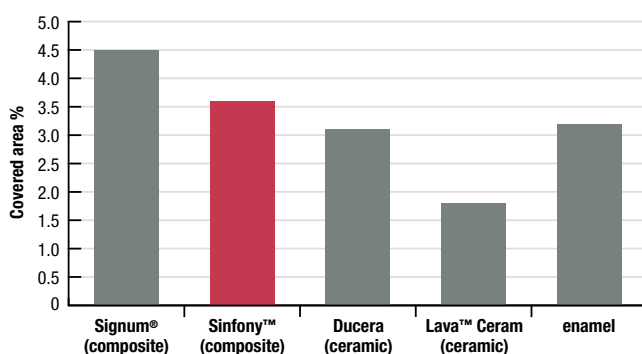
Material		enamel	Signum® (com- posite)	Sinfony™ (com- posite)	Ducera (ceramic)	Lava™ Ceram (ceramic)	Den- titan (CoCrMo)	tita- nium
Covered area [%]	w/o pellicle	3.2	4.5	3.6	3.1	1.8	1.5	2.0
	w/ pellicle	1.0	2.1	0.6	0.6	0.6	0.7	0.6

Conclusions: With a salivary pellicle the area covered by *S. mutans* is significantly smaller. The differences are less pronounced with the pellicle, indicating that pellicle covers possible bacterial binding sites. Signum retains significantly more bacteria than the other materials.

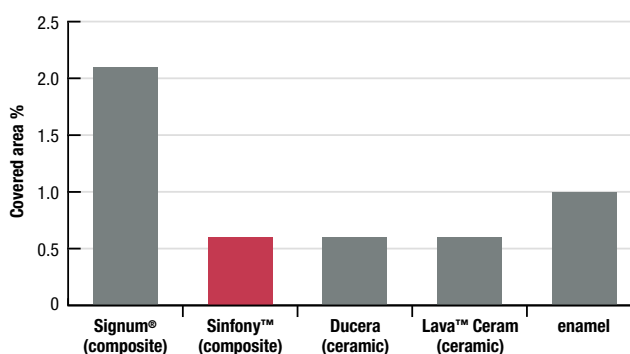
Aim of the Study: The aim of the study was to determine the adherence of oral bacteria to dental materials.

Results of the Study: 3M™ ESPE™ Sinfony™ shows a very low adhesion to bacteria, comparable to ceramic materials.

Bacterial adherence without salivary pellicle



Bacterial adherence with salivary pellicle



Influence of Surface Roughness on Bacterial Adhesion to Dental Facing Composites

T. REGNET, G. GRÖGER, M. ROSENTRITT, M. BEHR, and G. HANDEL, University of Regensburg, Germany

Objectives: This study investigated the influence of surface roughness on the adhesion of streptococcus mutans to resin facing composites.

Methods: 3 samples (diameter 10 mm, thickn. 2 mm) of each material: belleGlass (bG) (Girrbach, G), Conquest Sculpture (CS) (Jeneric & Pentron, USA), Dialog (Dia) and Dialog occlusal (Diaoc) (Schütz Dental, G), Signum (Sig) (Heraeus Kulzer, G), Solidex (Sol) (Shofu Dental, G), Sinfony (Sin) (3M ESPE, G) and Targis (Tar) (Ivoclar-Vivadent, FL) were made according to the manufacturer's instructions and finished using wet abrasive paper with a grit of 1000, 2000 or 4000, respectively. Enamel-surfaces (En) of human molars were used as controls. The arithmetic roughness (Ra) was determined with a Perthometer S6P (Mahr-Feinprüf, G). The specimen were incubated at 37°C with *S. mutans* ATCC25175 (DSMZ, G) for 4 hours. The proportional areas covered by adhering bacteria were quantitatively measured with a scanning electron microscope (Stereoscan 240, Cambridge Instr., G) and images were analyzed with Optimas 6.2 (Media Cybernetics, USA). Medians and 25%-75% percentiles were calculated. Statistics: Mann-Whitney-U-test ($p < 0.05$).

Results:

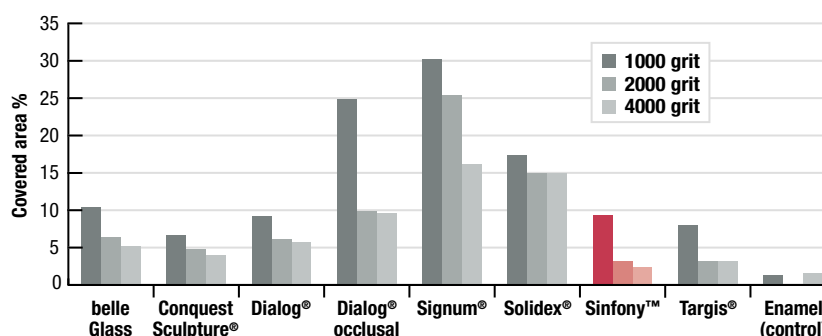
Material		bG	CS	Dia	Diaoc	Sig	Sol	Sin	Tar	En
Covered area [%]	1000 grit	10.4	6.6	9.2	24.8	30.2	17.3	9.3	8.0	1.3
	2000 grit	6.4	4.8	6.1	9.9	25.4	14.9	3.2	3.4	–
	4000 grit	5.2	3.9	5.7	9.6	16.1	14.7	2.3	3.2	1.5

In most cases the bacterial adhesion could be reduced by final polishing with higher grit. Only the reduction of bacterial adhesion between a grit of 1000 and 2000 was significant. Reduction by further polishing with a grit of 4000 was not significant. After 4000 grit polishing all materials showed a similar level of bacterial adhesion with the exception of Signum and Solidex, where the bacterial adhesion was significantly higher.

Conclusions: Different grades of final polishing have a high influence on the susceptibility for bacterial adhesion on dental facing composites.

Aim of the Study: This study evaluated the influence of surface roughness on the adhesion of streptococcus mutans to the composites BelleGlass (Girrbach), Conquest® Sculpture® (Jeneric/Pentron®), Dialog® (Schütz Dental), Dialog® occlusal (Schütz Dental), Signum® (Heraeus Kulzer®), Solidex® (Shofu® Dental), 3M™ ESPE™ Sinfony™ and Targis® (Ivoclar-Vivadent®)

Results of the Study: After 1000, 2000 and 4000 grit polishing 3M™ ESPE™ Sinfony™ shows a very low level of bacterial adhesion. The reduction of bacterial adhesion between a grit of 1000 and 2000 was significant.

Bacterial covered areas depending on surface roughness



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