Composite Materials

THE OHIO STATE UNIVERSITY
COLLEGE OF DENTISTRY

- Composites: Have they replaced amalgam?
- New Composite Developments
  - Bulk Fill: Facts and Fictions?
  - Bioactive composites ?
- Using Composites in high risk patients
- Composites as buildup materials.

Composite Resins

1950's: glass filled PMMA
1960's: PMMA → Bis-GMA
Mid 1970's: Self-cure → UV cured
Late 1970's: UV-cure → visible light cured
Late 1970's: Bis-GMA → other monomers
Late 1970's: macrofill → microfill
Early 1980's: macrofill → hybrid
Mid 1980's: direct → indirect
Late 1980's: hybrid → small particle
Mid 1990's: flowables and packables
Mid-1990's: small particle → microhybrids
~2000: microfills → nanofills and nanohybrids
Mid-2000's: low-shrink formulations
~2010: self-adhesive flowables/restoratives

Evolution of Dental Composites

DENTAL MATERIALS 27 (2011) 29–38

Resin composite—State of the art

Jack L. Ferracane*
Department of Restorative Dentistry, Oregon Health & Science University, Portland, OR 97239, USA

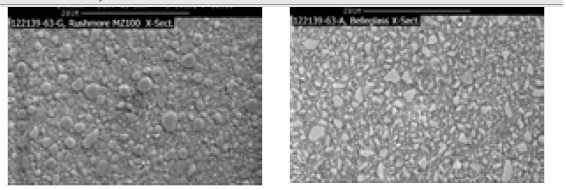
DENTAL MATERIALS 27 (2011) 955–963

22-Year clinical evaluation of the performance of two posterior composites with different filler characteristics

Paulo A. Da Rosa Rodolpho[a], Tiago A. Donassollo[b], Maximiliano S. Cenci[b], Alessandro D. Loguércio[c], Rafael R. Moraes[b], Ewald M. Bronkhorst[d], Niek J.M. Opdam[d], Flávio F. Demarco[b,*]

Table 1 – Characteristics of the resin composites evaluated.[a]

Material	Classification[b]	Filler			Ra	E	CS	VHN
		MPS	Vol.%[A]	Vol.%[B]				
Herculite XR	Midifilled hybrid	1.0	55	57	0.12	16	397	74
P-50 APC	Minifilled hybrid	2.1	~~70~~ 66	~~77~~	0.48	25	395	159



0.6 µm average

3M™ Paradigm™ MZ100 SEM *Belleglass™ SEM*

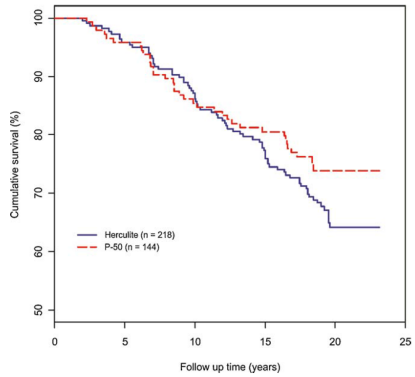


Fig. 1 – Survival curves (Kaplan–Meier) for P-50 and Herculite over the 22-year observation period.

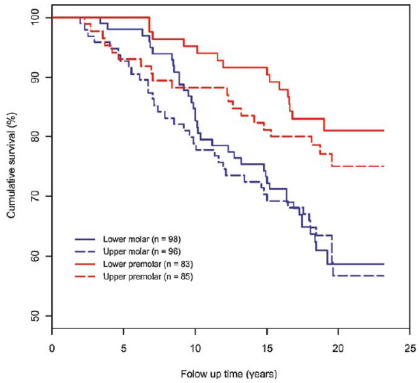


Fig. 3 – Survival curves (Kaplan–Meier) for tooth type.

Available Bulk Fill Materials

Flowable liners/bases:
- Surefil SDR Flow (Dentsply)
- Filtek Bulk Fill (3M ESPE)
- Venus Bulk Fill (Heraeus Kulzer)
- X-tra Base (Voco)

Bulk fill flowable with universal cap

Restorative:
- Tetric Evo Ceram Bulk Fill (Ivoclar)
- Sonic Fill (Kerr)
- X-tra fil (Voco)

SonicFill System

Other Restorative (older): Alert (Pentron), QuiXX (Dentsply)

DEPTH OF CURE

Study	Material	Method	Cure Energy	Cure Depth
Campodonico, 2011	***Xtrafil***	***KHN (Tooth)***	***24 J/cm²***	***> 3.5 mm***
Flury, 2012	***SDR, Venus, Tetric***	***ISO4049***	***10 J/cm²***	***4+ SDR, Venus not Tetric***
Finan, 2013	***Xtrabase, SDR***	***DC KHN (mold)***	***13 J/cm²***	***4+ All pass***
Tiba, 2013	***Sonic, Tetric, Xtrafil, Xtrabase, Venus, SDR, Filtek***	***ISO4049 KHN (80%)***	***Varied (manuf. recom.)***	***Tetric and Sonic just fail by ISO 4+ All (80% test)***
Czasch, 2013	***SDR, Venus***	***DC KHN (mold)***	***24 J/cm²***	***4+ All pass***
El Damanhoury, 2013	***SDR, Venus, Filtek, Tetric, Xtrafil***	***KHN (mold)***	***20 J/cm²***	***4mm All pass***

CURING STRESS

- Consensus:
  - Bulk fill composites generally show reduced contraction stress and cuspal deflection, especially those used as bases, likely due to a combination of factors: fewer C=C conversions, lower stiffness, stress relief
    - El-Damanhoury and Platt, Oper Dent, 2013 (epub; in press)
    - Rullman et al., Schweiz Monatsschr Zahnmed 122:4:294-8, 2012
    - Moorthy et al., J Dent 40:500-5, 2012
    - Van Ende et al., Dent Mater 29:269-77, 2013.

MARGINAL QUALITY

- Consensus:
  - Bulk fill composites (placed in bulk or incrementally) generally show similar marginal adaptation and leakage as conventional composites placed incrementally.
    - Roggendorf et al., J Dent 39:643-7, 2011
    - Moorthy et al., J Dent 40:500-5,2012
    - Juloski et al., Am J Dent 26:271-7, 2013
    - Campos et al., J Dent, 2014 (epub, in press)
    - Furness et al., J Dent 2014 (epub, in press)

PHYSICAL PROPERTIES

- Consensus:
  - Bulk-fill composite properties approach but are typically lower than micro/nanohybrids.
  - Those designed as needing a capping material should have one.
    - El-Safty et al., Dent Mater 28:928-35, 2012
    - Tiba et al., ADA PPR 8(3):13-26, 2013
    - Ilie et al., Oper Dent, 2013 (epub, in press)
    - El-Damanhoury and Platt, Oper Dent (epub, in press)

SUMMARY

In vitro evidence suggests that bulk fill composites:

meet their claims regarding depth of cure
- enhanced translucency; more efficient curing

typically have lower contraction stress than micro/ nanohybrid composites, but equivalent marginal adaptation and sealing
- lower E or shrinkage; stress modulation

have lower physical properties in general than micro/ nanohybrid conventional composites
- typically lower filler levels; pre-polymerized resin fillers

Clinical outcomes? Expect comparable outcomes.

Name	Fillers	Size	Resin	Vol%
P50	ZrSiO spheres	3.5-.01 (avg 0.6 µm)	bis-GMA, TEGDMA	66
P60	ZrSiO spheres	3.5-.01 (avg 0.6 µm)	bis-GMA, bis-EMA (6), UDEMA	66
Z100	ZrSiO spheres	3.5-.01 (avg 0.6µm)	bis-GMA, TEGDMA	66
Z250	ZrSiO spheres	3.5-.01 (avg 0.6µm) dense pack	bis-GMA, bis-EMA (6), UDEMA,Tegdma	60
Z350	ZrSiO nanospheres nanoclusters	20 nm 5-20 nm 0.6-1.4 µm	bis-GMA, bis-EMA (6), UDEMA,Tegdma	59.5
Supreme Plus	ZrSiO nanospheres nanoclusters	75 nm 0.6-1.4 µm	bis-GMA, bis-EMA (6), UDEMA, Tegdma	57.7
Supreme XT (Optical)	ZrSiO nanospheres nanoclusters ZrO nanospheres	20 nm 5-20 nm 0.6-10µm 4-11 nm	bis-GMA, bis-EMA (6), UDEMA, Tegdma	55.6 -63.3
Bulk Fil	ZrSiO nanospheres nanoclusters ZrO nanospheres YbF3	20 nm 5-20 nm 0.6-10µm 4-11 nm 100 nm	AUDMA, UDMA, 1-12 dodecane DMA (New methacrylate monomers)	58.4

What we know about Posterior Composites

- can have good longevity
- are at greater risk of recurrent caries than amalgam (3-4 X risk)
- Composites in premolars perform better than in molars
- smaller volumes perform better than larger composites
- Technique matters

Class II Sandwhich Technique

239 class II cavities @ 3 yrs

5% failure (12 restorations)

7 partial fractures of composite

3 secondary caries

Van Dijken et al. (1999): Longevity of extensive class II open-sandwich restorations with a RMGI cement J Dent Res 78:1319-1325

Class II Sandwhich Technique

220 class II cavities @ 6 yrs

47% in high caries risk patient

19% failure

10 secondary caries

20 tooth or materials fractures

dissolution of RMGI can become a problem in high caries risk patients

Andersson-Wenckert IE, van Dijken JW, Kieri C. Durability of extensive Class II open-sandwich restorations with a resin-modified glass ionomer cement after 6 years. Am J Dent 2004;17:43-50.

CLINICAL REVIEW

N.J.M. Opdam[1]*, F.H. van de Sande[2], E. Bronkhorst[1], M.S. Cenci[2], P. Bottenberg[3], U. Pallesen[4], P. Gaengler[5], A. Lindberg[6], M.C.D.N.J.M. Huysmans[1], and J.W. van Dijken[6]

J Dent Res 93(10):943-949, 2014

11 data sets from 8 authors

Longevity of Posterior Composite Restorations: A Systematic Review and Meta-analysis

The presence of a liner or base from glass-ionomer cement was shown to have a negative influence on survival of the restoration. However, without the 2 large practice-based studies, this effect was not found, indicating that this finding was related to those datasets and may be related to operator factors.

Table 3. Annual Failure Rates for the Restorative Groups

Annual Failure Rates	Five-year, %	Ten-year, %
All restorations (n = 2,816)	1.8	2.4
Restorations in high-caries-risk* patients (n = 547)	3.2	4.6
Restorations in medium-caries-risk* patients (n = 385)	3.5	4.1
Restorations in low-caries-risk* patients (n = 1,815)	1.2	1.6
Lining/base GIC present (n = 963)	2.2	2.7
No lining/base GIC present (n = 1,853)	1.7	2.2
Compact-filled hybrid resin composites (n = 1,170)	1.6	2.2
Midway-filled hybrid resin composites (n = 1,646)	1.9	2.3

*For 68 individuals, the caries risk could not be established.

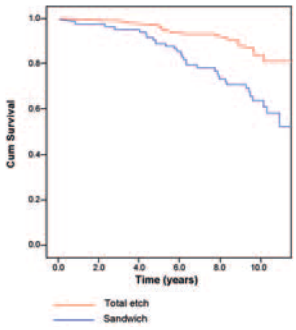
Failure analysis

Longevity and Reasons for Failure of Sandwich and Total-etch Posterior Composite Resin Restorations

Niek J. M. Opdam[a]/Ewald M. Bronkhorst[a]/Joost M. Roeters[b]/Bas A. C. Loomans[a]

J Adhes Dent 2007; 9: 469-475.

Failure analysis

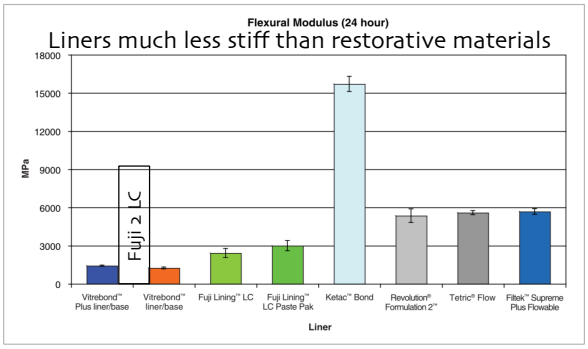


overall survival greater with total etch than with open Sandwich (Vitrebond-RMGI liner)

Flexural Modulus

Flexural modulus is a method of defining a material's stiffness. A low modulus indicates a flexible material. The flexural modulus is measured by applying a load to a material specimen that is supported at each end.

Liners much less stiff than restorative materials



Are there other materials that work?

JOURNAL OF DENTISTRY 35 (2007) 124–129

Nine-year evaluation of a polyacid-modified resin composite/resin composite open sandwich technique in Class II cavities

Anders Lindberg[a,], Jan W.V. van Dijken[a], M. Lindberg[b]*

[a] *Department of Odontology, Dental School Umeå, Umeå University, 901 87 Umeå, Sweden*
[b] *Public Dental Health Clinic Seminariegatan, Skellefteå, Sweden*