



Clinical and more biocompatible products



# BIOCOMPATIBILITÉ DES PRODUITS DENTAIRES

Les composites dentaires,  
Une bombe à retardement?



# Bisphenol A and Related Compounds in Dental Materials

*Abby F. Fleisch, Perry E. Sheffield, Courtney Chinn, Burton L. Edelstein and Philip J. Landrigan*

*Pediatrics 2010;126:760; originally published online September 6, 2010;*

18/07/2017

## Conclusions

....Use of these materials should be minimized during pregnancy whenever possible.

Manufacturers should be required to report complete information on the chemical composition of dental products and encouraged to develop materials with less estrogenic potential....

*Pediatrics 2010;126:760–768*

# Assessment of HEMA and TEGDMA induced DNA damage by multiple genotoxicological endpoints in human lymphocytes

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*Dental materials 31 (2015) 865–876*

## Conclusion

**Considering the bioavailability of the resin monomers HEMA and TEGDMA, the findings of the present study suggest the necessity for further investigations regarding the local and systemic reaction of these compounds in vitro and in vivo. The utilization of these compounds should also be monitored and a careful indication in odontology is recommended.**

# Biodegradation of resin composites and adhesives by oral bacteria and saliva:

## A rationale for new material designs that consider the clinical environment and treatment challenges

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*dental materials 30 (2014) 16–32*

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....Enzymatic hydrolysis of both mono- and di-methacrylate monomers such as HEMA, TEGDMA, Bis GMA was observed. TEGDMA underwent greater degradation in comparison to Bis GMA.....

....Human saliva completely degraded Bis GMA and TEGDMA within 24 h...

....Both monomers exhibited cytotoxic and genotoxic effects with greater toxicity observed from TEGDMA.....

# Cytotoxic and mutagenic effects of dental composite materials

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Agathe Nussera, Stefanie Steinhausera, Janusz Wieczoreka, Rudolf Vasoldb, Gottfried Schmalza*

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*Received 17 February 2004; accepted 12 May 2004*

## Conclusion

....However, our findings suggest that it is desirable to replace cytotoxic and mutagenic components of biologically active composite resins by more biocompatible substances to avoid a potential risk for the health of patients and dental personnel.

# Cytotoxic Effects of Resin Components on Cultured Mammalian Fibroblasts

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....Leaching from resin composites may occur at two points in time: during the setting period of the resin, and later when the resin is degraded. Leaching during the first process

is related to the degree of conversion or the chaining of the oligomer into a polymer (Ruyter and Oysaed, 1987; Rueggeberg and Craig, 1988; Ferracane and Condon, 1990).

....After polymerization, hydrolytic degradation over a longer period of time is also capable of releasing resin material. Tissue, bacterial, and salivary esterases are capable of hydrolyzing significant percentages from these polymers<sup>6</sup>

(Oysaed and Ruyter, 1986; Freund and Munksgaard, 1990)...

# Cytotoxicity of the dental composite component TEGDMA and selected metabolic by-products in human pulmonary cells

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c Department of Operative/Restorative Dentistry, Periodontology and Pedodontics, Ludwig-Maximilians-University of Munich, 80336 Munich, Germany

Dental materials 24 (2008) 1670–1675

18/07/2017

## Conclusion

The results of this study indicate, that from all investigated TEGDMA-intermediates, 2,3-EMA was identified to have the highest cytotoxicity in pulmonary A549 cells.

In vivo, TEGDMA-intermediates are excreted via the lungs, but do not reach Cytotoxic levels [9].

However, possible mutagenic effects of 2,3-EMA will need further investigations.

# Determination of Bisphenol A Released from ResinBased Dental Composite Restoratives

ADA Laboratory researchers who conducted this study: Amer Tiba, Ph.D., Stephen E. Gruninger and Rashad Vinh. The authors thank Drs. Gary Schumacher and Ray Bowen from the Dr. Anthony Volpe - Research Center in Gaithersburg, Maryland.

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## Discussion

Although manufacturers of dental restorative resin materials no longer add BPA to their products, there are several ways that composites may contribute to BPA exposure, such as:

- from residual unreacted BPA present in raw materials used to produce the resin restoratives;
- after enzymatic degradation of polymerized materials by salivary esterases;
- in the formation of an oxygen inhibited layer of incompletely polymerized resin on the restoration surface;
- in the overall reduction in the degree of conversion of monomer to polymer in composites as a result of inadequate lightcuring....

## Conclusion

**This study shows that bis GMA based dental restorative materials have the potential to release BPA at a detectable level....All sources of raw bis GMA had detectable levels of BPA....**

# HPLC analysis of potentially harmful substances released from dental filing materials available on the EU market

Konrad Małkiewicz<sup>1</sup>, Alfred Owoc<sup>2</sup>, Mariusz Kluska<sup>3</sup>, Kinga Grzech-Leśniak<sup>4</sup>, Jadwiga Turlo<sup>5</sup>

<sup>1</sup> Department of Orthodontics, Medical University of Warsaw, Poland - <sup>2</sup> College of Public Health, Zielona Góra, Poland - <sup>3</sup> Institute of Chemistry, Siedlce University of Natural Sciences and Humanities, Poland

<sup>4</sup> Private Practice, Krakow, Poland - <sup>5</sup> Department of Drug Technology and Pharmaceutical Biotechnology, Medical University of Warsaw, Poland. *Annals of Agricultural and Environmental Medicine* 2014, Vol 21, No 1, 86–90

18/07/2017

## Abstract

**Introduction.** Incomplete cross-linking of composite dental materials leads to their susceptibility to degradation in the environment of non-organic and organic solvents, contributing to the release of chemical compounds which are potentially harmful to living organisms.

## Conclusion

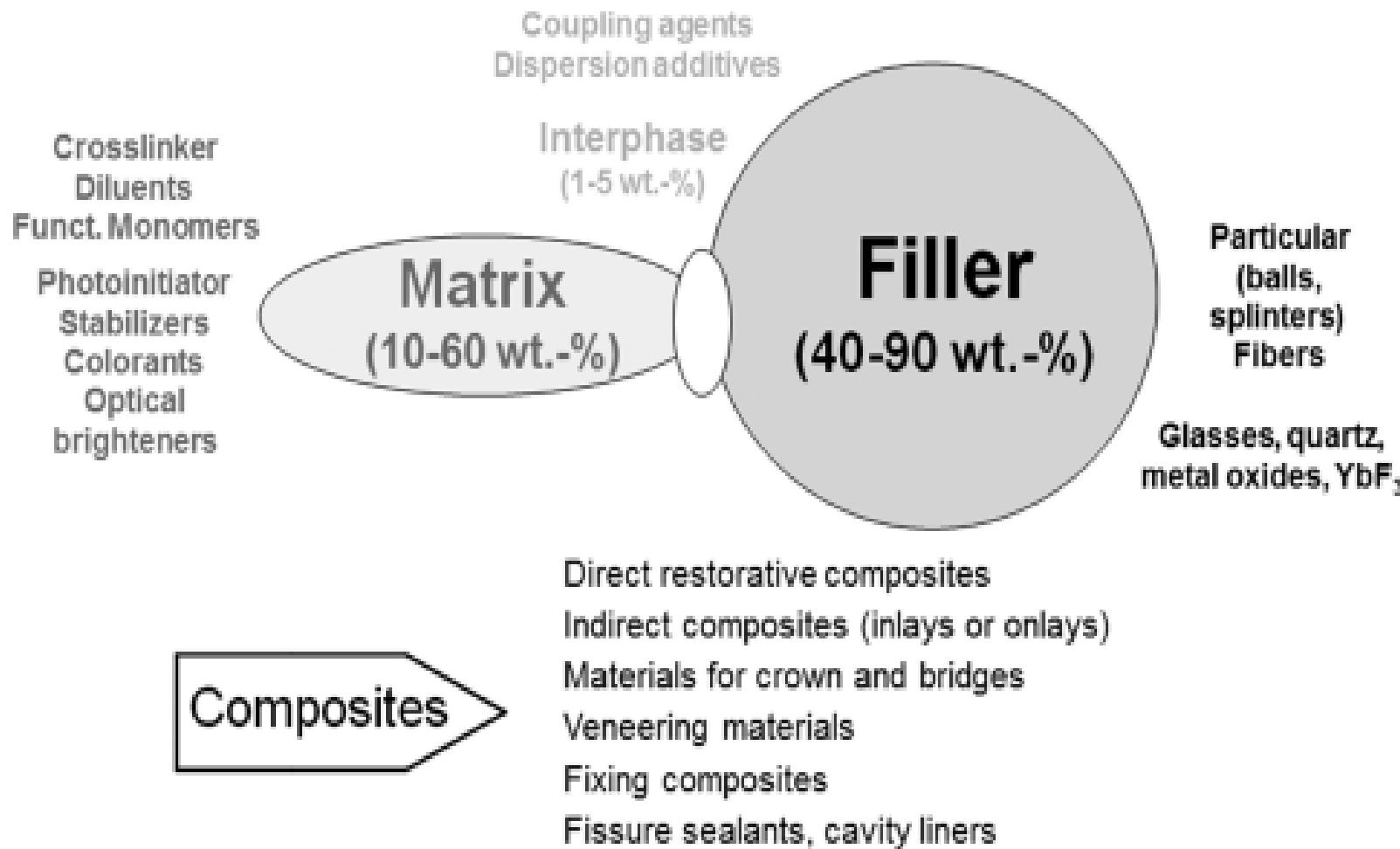
**...The examined composites used for the reconstruction of hard tissues of teeth remain chemically unstable after polymerization, and release potentially harmful substances in conditions of the presented study...The dynamics of the releasing of potentially harmful substances is correlated with the period of sample storage in water.**



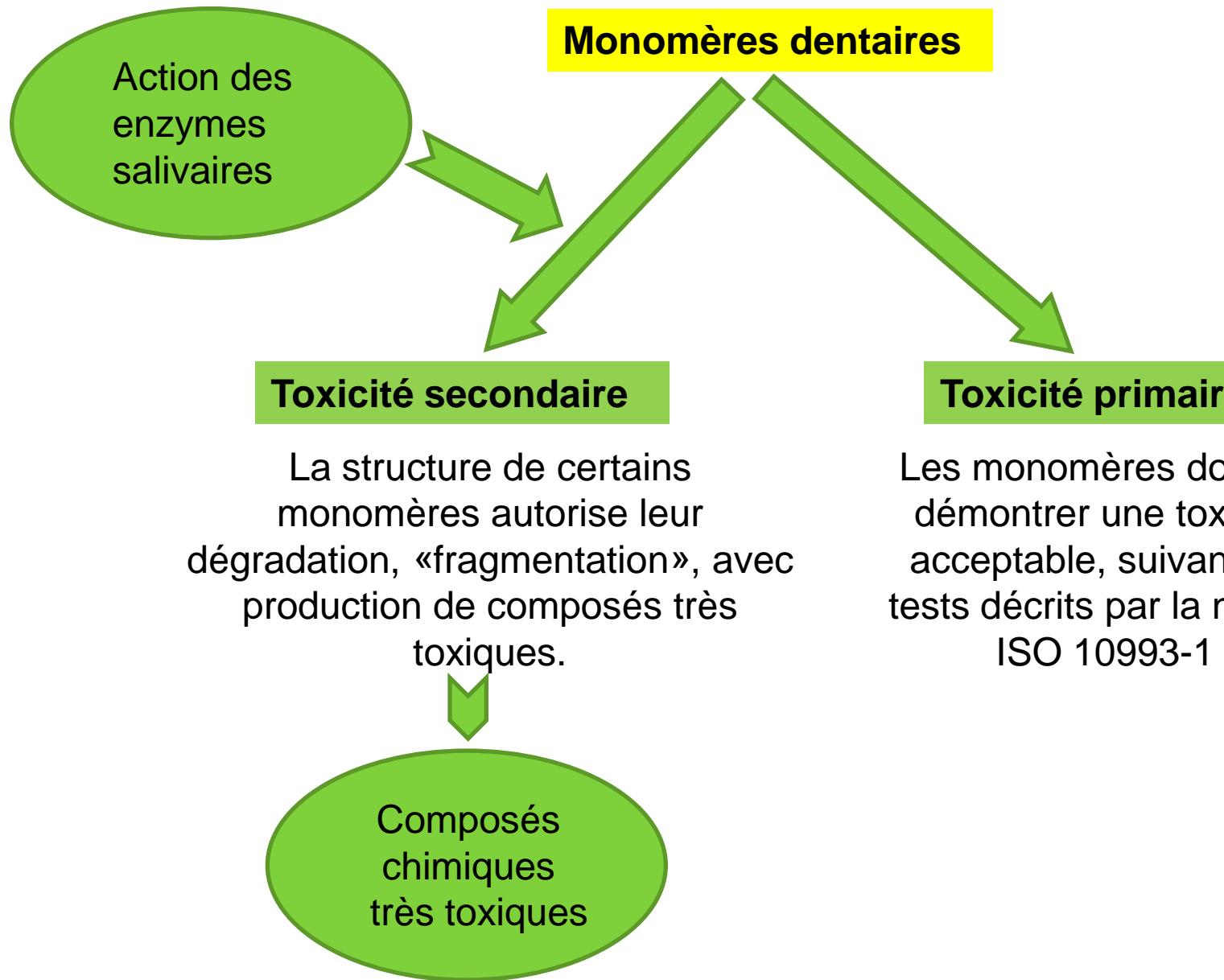
En 2014, **ELSODENT**, seul fabricant français de composites dentaires, a entamé une conversion profonde pour se diriger vers une dentisterie plus biocompatible et éco-responsable. Elle a choisi d'utiliser des monomères ayant une toxicité finale beaucoup plus faible, pour protéger l'organisme et l'environnement.

Nos formulations sont modifiées au fur et à mesure, afin d'éliminer en priorité le **TEGDMA**, un des produits les plus utilisés pour la fabrication des consommables dentaires et aussi l'un des plus nocifs. Il est présent à une concentration importante (entre 8 et 10%) dans la plupart des composites d'obturation, entre autres. Bien sûr, nous faisons également le nécessaire pour éliminer aussi le **BPA (Bisphénol A)** de tous nos produits.

# CHIMIE DES COMPOSITES DENTAIRES



# TOXICITE PRIMAIRE ET SECONDAIRE DES RESINES DENTAIRE



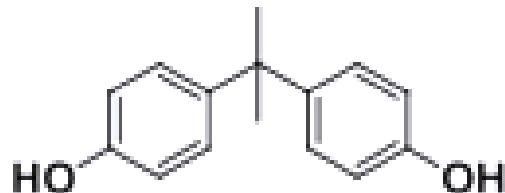
# Monomères utilisés dans les résines & composites dentaires

## Bisphenol A Glycidyl Methacrylate (BIS-GMA)

Monomère le plus utilisés dans les composites et résines dentaires.

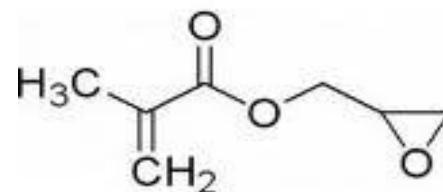
Il est synthétisé à partir de:

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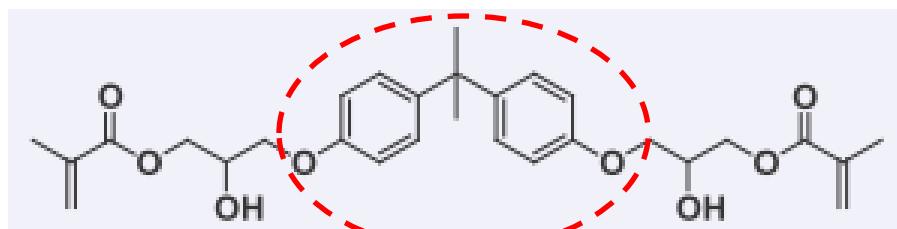


Bisphenol A

+



Glycidyl Methacrylate

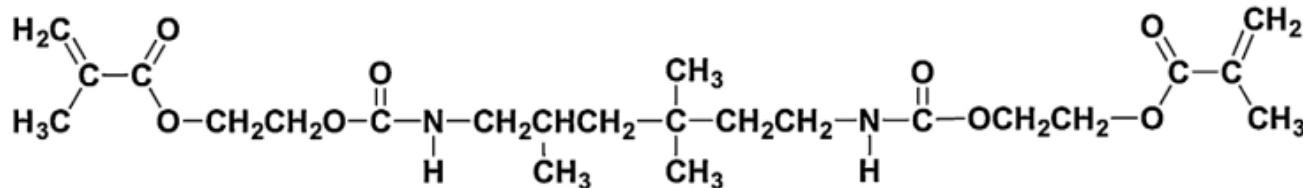


Bis GMA

Le Bis GMA est toujours mélangé au TEGDMA.

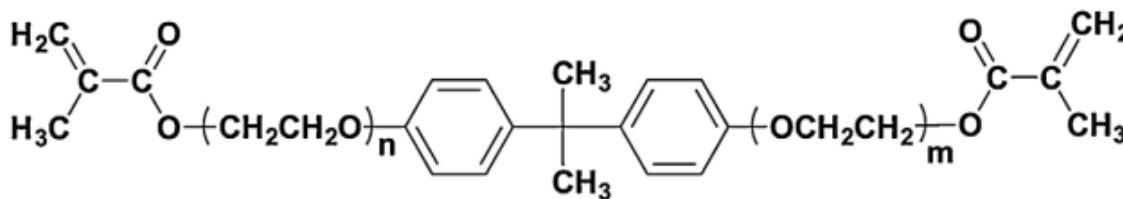
Le plus souvent, la matrice organique des composites contient aussi du UDMA.

# Monomères utilisés dans les résines & composites dentaires



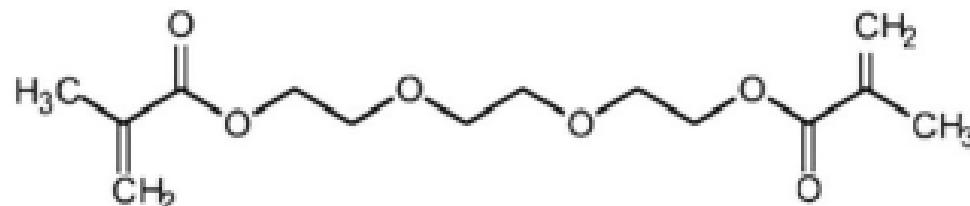
**UDMA**  
Mw = 470.6

Urethane dimethacrylate (UDMA)



**Bis EMA**  
Mw = 540

Ethoxylated bisphenol A based dimethacrylate (BisEMA)

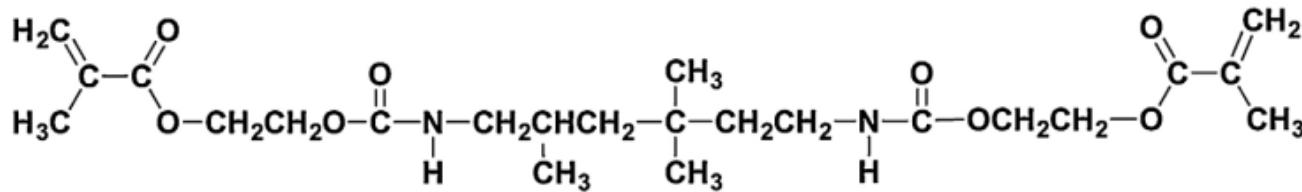


**TEGDMA**  
Mw = 286.3

Triethylene glycol dimethacrylate (TEGDMA)

# Caractéristiques et utilisation de ces monomères dans les produits dentaires

## Urethane dimethacrylate (UDMA)



### CHARACTERISTIC

- Résistance à la flexion élevée
- rétraction importante durant la polymérisation

### TOXICITE

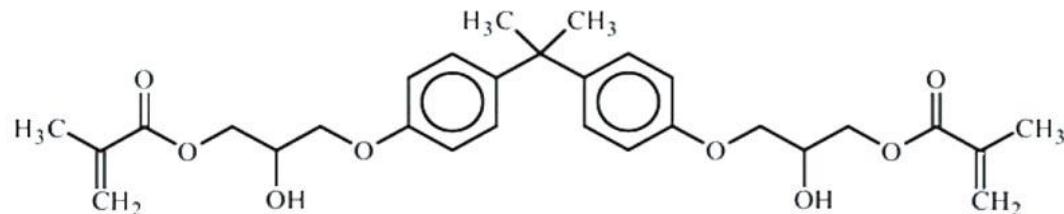
- Non hydrolysable : Toxicité primaire mais pas de toxicité secondaire

### UTILISATION

- Résines pour C & B provisoires
- Composites

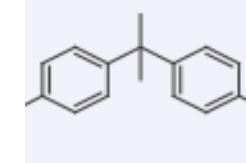
# Caractéristiques et utilisation de ces monomères dans les produits dentaires

## Bisphenol A Glycidyl Methacrylate (Bis GMA)



### CARACTERISTIQUES

- Trop visqueux: nécessité d'utiliser un diluant, comme le **TEGDMA** pour pouvoir ajouter ensuite des charges minérales
- Rétraction faible au cours de la polymérisation ➔
- Résistance à la flexion élevée ➔



Presence of aromatic rings

### TOXICITE

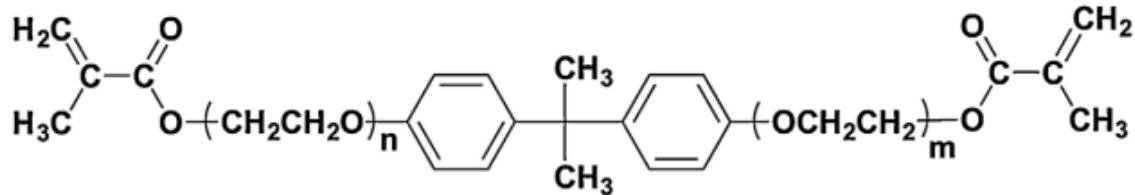
- Hydrolysable: Toxicité primaire et secondaire

### UTILISATION

- Résines pour C & B provisoires
- Composites

# Caractéristiques et utilisation de ces monomères dans les produits dentaires

## Ethoxylated bisphenol A Glycidyl Methacrylate (BisEMA)



### CARACTERISTIQUES

- Moins visqueux que le **Bis GMA**. Peut être utilisé sans **TEGDMA**
- Propriétés mécaniques plus faibles que le **Bis GMA**.
- Sa structure chimique ne permet pas son adhésion aux autres résines, ou aux charges minérales.
- Utilisé quand la cohésion globale du matériau n'est pas la priorité.

### TOXICITE

- Hydrolysable: Toxicité primaire et secondaire

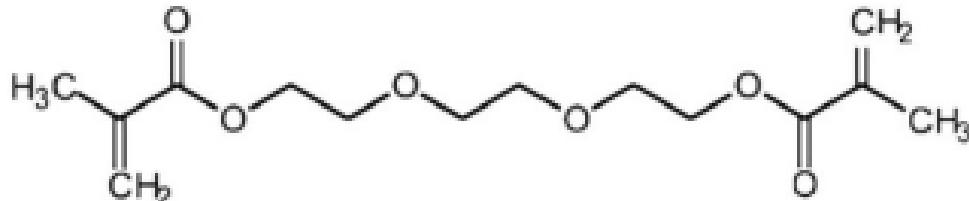
### UTILISATION

- Résines pour C & B provisoires
- Composites

# Caractéristiques et utilisation de ces monomères dans les produits dentaires

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## Triethylene glycol dimethacrylate (TEGDMA)



### CHARACTERISTIQUES

- **Poids moléculaire faible, monomère fluide.** Utilisé comme diluant pour le **Bis GMA**.
- Le mélange à un taux de conversion (= taux de polymérisation) élevé, ce qui donne de meilleures propriétés mécaniques à la matrice organique mais avec un taux de rétraction élevé.

### TOXICITY

- Facilement hydrolysable : Toxicité primaire et secondaire

### UTILISATION

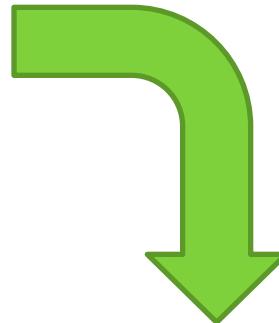
- Molécule présente dans la plupart des résines et composites dentaires.

# Biocompatibilité

## Taux de conversion, relargage et dégradation des monomères

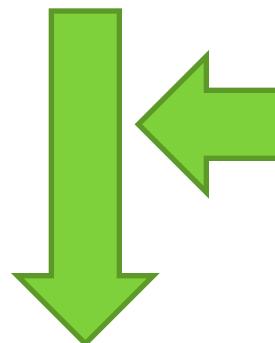
La polymérisation des monomères présents dans les composites n'est jamais de 100%

Taux de polymérisation max. :  
**55 à 63%**



Il est difficile de quantifier le relargage de monomères non polymérisés en bouche.

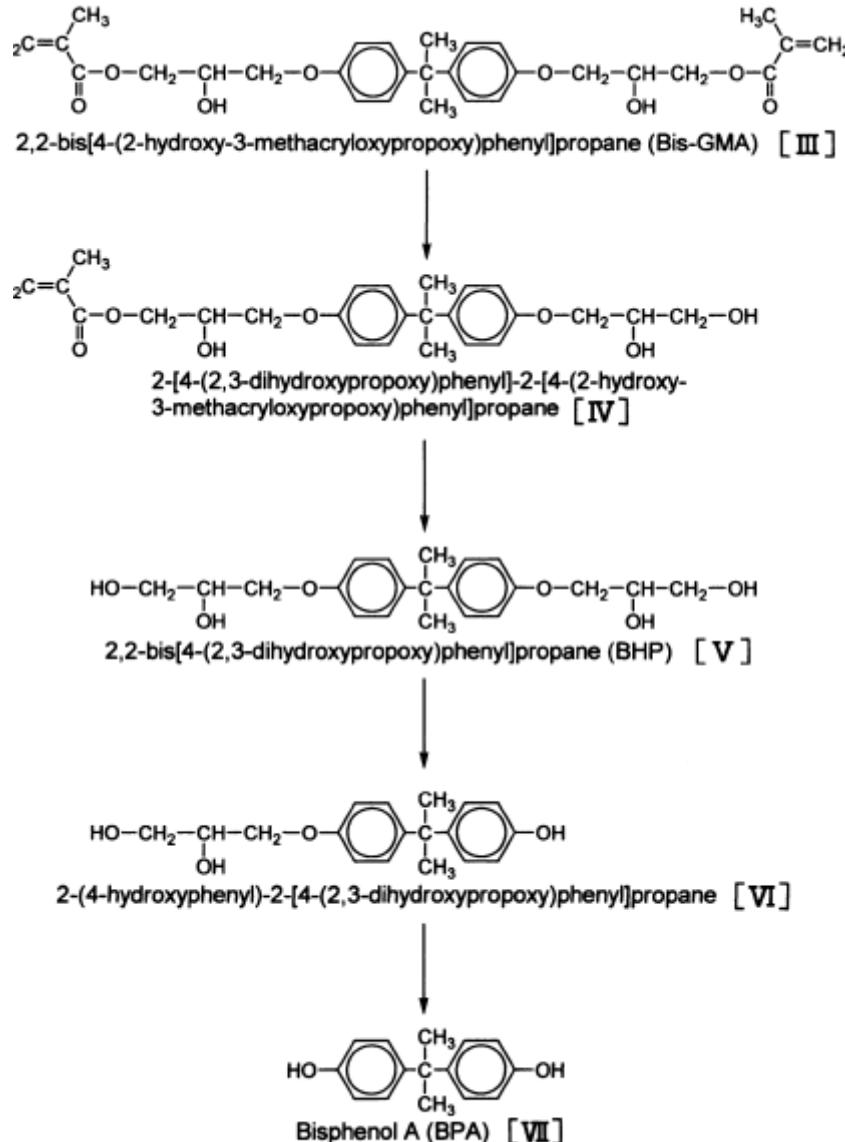
Premières molécules à être libérées seront les plus petites et les plus fluides, comme le **TEGDMA**, puis le **BIS GMA** et le **Bis EMA** et l'**UDMA**



Attaque enzymatique (dégradation ou hydrolyse) des monomères libérés et production en bouche de résidus toxiques, sous certaines conditions

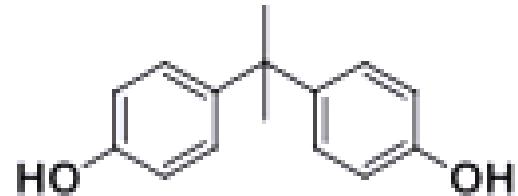
Rejet en bouche de **BPA** et de **Formaldéhyde**

# Bis GMA - Hydrolyse



g. 11 Schematic representation of BPA formation from Bis-GMA by hydrolysis and subsequent ether fission.

# Bis GMA – Toxicité secondaire Bisphenol A



Le **BPA libre**, présent dans les produits dentaires est issu de la fabrication du **Bis GMA** et du **Bis EMA**. Il provient aussi de sa dégradation, quand il est relargué en bouche, par les composites.

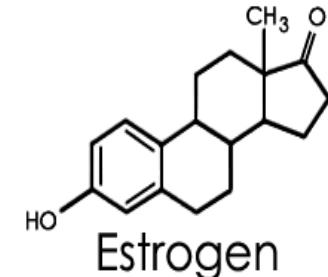
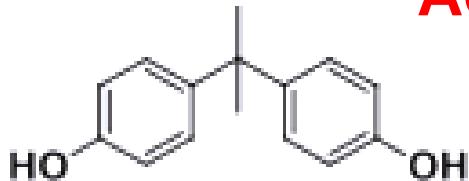
Les résines synthétisées à partir de **BPA** contiennent des traces de **BPA libre** (~2 ppm) (Schmalz G et al.).

Le **BPA** est détectable dans la salive 3 heures après la mise en place du composite. Par contre, la quantité et la période de relargage systémique de **BPA** n'est pas établie, à partir des données actuellement disponibles.

La question du relargage de résines, notamment le **BPA** à partir des composites dentaires n'est pas nouvelle, puisqu'elle date de 1998.

# Bis GMA – Toxicité secondaire

## Action oestrogénique du BPA



Le **BPA** est considéré comme étant faiblement oestrogénique.

Il peut donc mimer les actions de l'oestrogène. Il possède d'autres effets négatifs sur la santé humaine :

- ✓ Effets potentiels sur l'obésité, Nadal et al.
- ✓ Effets potentiels sur le développement du cerveau, chez le foetus et l'enfant, helby et al.
- ✓ Effets potentiels sur le système dopaminergique (cerveau) Jones et al
- ✓ Effets potentiels sur le système reproductif et le comportement sexuel, Smith et al.

Nadal A. Obesity: Fat from plastics? Linking bisphenol A exposure and obesity. Nat Rev Endocrinol. 2013; 9: 9-10.

Shelby MD. monograph on the potential human reproductive and developmental effects of bisphenol A. NTP CERHR MON. 2008; 22: vii-ix.

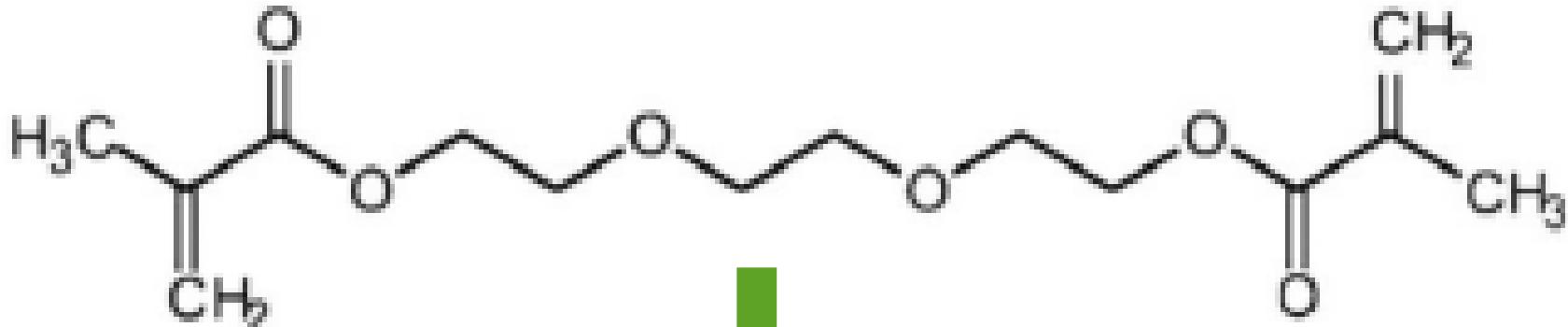
Jones DC, Miller GW. The effects of environmental neurotoxicants on the dopaminergic system: A possible role in drug addiction. Biochem Pharmacol. 2008; 76: 569-581.

Smith CC, Taylor HS. Xenoestrogen exposure imprints expression of genes (Hoxa10) required for normal uterine development. FASEB J. 2007; 21: 239-246.

Li D, Zhou Z, Qing D, He Y, Wu T, Miao M, et al. Occupational exposure to bisphenol-A (BPA) and the risk of self-reported male sexual dysfunction. Hum Reprod. 2010; 25: 519-527.

# TEGDMA – Toxicité primaire

Triethyleneglycol dimethacrylate

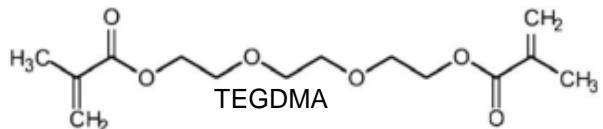


Faible poids moléculaire  
(fluide)

TEGDMA  
MW 286.3

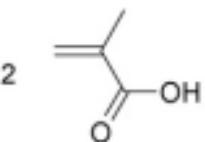
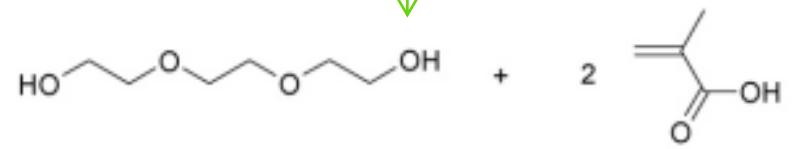


Pénètre facilement dans les  
membranes cellulaires des mammifères

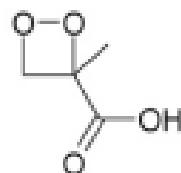
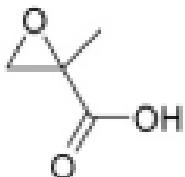


# TEGDMA – Hydrolyse

## Degradation du TEGDMA

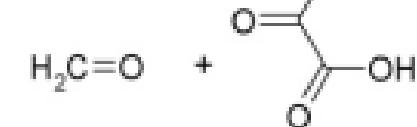
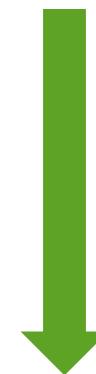


Facilement hydrolysé par les enzymes salivaires (monomère à chaîne courte), hautement毒ique pour l'organisme (irritations locales, allergies, cancérogènes, etc).



2,3-Epoxy methacrylic acid

2,3-Epidioxy methacrylic acid



Formaldehyde

Pyruvic acid

**Relargage de composés hautement toxiques comme le formaldehyde et l'acide pyruvique**

# Toxicité des composites, taux de conversion et rétraction volumétrique

Il ya une corrélation évidente entre le degré de conversion (polymérisation) des composites avec leur toxicité et leur rétraction lors de la prise.

**Plus le degré de conversion est élevé  
Plus la rétraction est élevée  
Plus la toxicité primaire et secondaire diminue**

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# Composition globale de la plupart des composites dentaires

Micro-hybrid & nano-hybrid Composites				
Products	Manufacturer	Classification	Composition	
			Matrix	Fillers
TPH3 Spectrum	DENTSPLY	Submicro hybrid composite	Bis-GMA, BisEMA, TEGDMA, photo initiators, and stabilizers	57 vol% (77wt%) BA-Al-B-Si (< 1 mm), Ba-F-Al-B-Si (< 1 mm), highly dispersed SiO <sub>2</sub> (10–20 nm)
Ceram X Duo	DENTSPLY	Nanohybrid	Methacrylate modified polysiloxane, dimethacrylate resin, fluorescence pigment, UV stabilizer, stabilizer, dl-Camphorquinone and ethyl-4 (dimethylamino) benzoate	57 vol% (76wt%) BA-Al-B-Si (1–1.5 mm) and methacrylate functionalised SiO <sub>2</sub> nano filler (10 nm)
Esthet X	DENTSPLY	Microhybrid	Bis-GMA, TEGDMA, Bis-EMA, camphorquinone, photoinitiator, stabilizer, and pigments	Filler: 60 vol% (61wt%) Barium alumino fluorosilicate glass (0.02–2.5 mm) and silica dioxide (10–20 nm)
Filtek Z250	3M <sup>I</sup>	Nanohybrid	Bis-GMA, Bis-EMA, UDMA, photo initiators, and stabilizers	Filler: 60 vol% (84.5wt%) Zirconium/silica filler (0.01–3.5 mm)
Filtek Z350	3M <sup>I</sup>	Nano-filled	UDMA, TEGDMA and BisEMA	Zirconia/silica and silica; nanoparticle; (78.5wt%, 59.5vol%)
Filtek P90 TM	3M <sup>I</sup>	Microhybrid	Silorane	Quartz and yttrium fluoride; Microhybrid (76wt%) (55vol%)
Filtek Supreme XT	3M <sup>II, III</sup>	Nanohybrid	Bis-GMA, TEGDMA, UDMA, Bis-EMA	59.5 vol%, 78.5wt%) Nano agglomerated/non aggregated silica filler (20 nm) and aggregated zirconia/silica cluster filler (0.6–1.4 mm) with primary particle size of 5–20 nm
Z 100	3M <sup>IV</sup>	Microhybrid	Bis GMA, UDMA, BisEMA, TEGDMA	zirconia/silica (66% vol) (0.01–3.5 μm)
P60	3M		Bis-GMA, UDMA, Bis-EMA, TEGDMA	Zirconia, silica (0.01–3.5 μm)
Filtek Z250 Universal	3M <sup>Erreur ! Signet non défini.</sup>		1–10 wt% BisGMA, <5wt% TEGDMA, 1–10wt% UDMA, 1–10wt% BisEMA(6)	75–85wt% silane treated ceramic filler. 0.01–3.5 mm zirconia/silica filler (average 0.6 m m)
Grandio	VOCO <sup>V</sup>	Nanohybrid	Bis-GMA, dimethacrylate, (UDMA), (TEGDMA).	silicium dioxide nanofillers (20–50 nm), glass ceramic microfillers (1 mm), Bariumalumina boro silicate: 0.1–2.5 μm mean 1000 nm
Herculite Precis	KERR		Bis-GMA, TEGDMA	prepolymerized filler (PPF), silica nanofiller (50 nm) and submicron hybrid filler (barium glass filler of 0.4 mm)
Solitaire 2	KERR		Bis GMA, TEGDMA, UDMA	
Premise	KERR <sup>VII</sup>	Nanohybrid	Bis-EMA, TEGDMA, initiators, and stabilizers	(69 vol%, 84wt%) Prepolymerized filler (30 to 50 mm), barium glass (0.4 mm), and SiO <sub>2</sub> (0.02 mm)
Herculite XRV	KERR		Bis-GMA, Bis EMA, TEGDMA	59 vol%, 80wt% Ba-Al-B-Si, TiO <sub>2</sub> , ZnO <sub>2</sub> , SiO <sub>2</sub> (0.6μm)

# Composition globale de la plupart des composites dentaires

4 Seasons	VIVADENT <sup>I</sup>		BisGMA, UDMA and TEDMA	Barium glass, ytterbium trifluoride, Ba-Al-fluorosilicate glass, highly dispersed silicon dioxide and spheroid mixed oxide; nanohybrid; (75–77wt%)(55–58vol%)
Clearfil Majesty Esthetics	KURARAY		Bis-GMA, hydrophobic aromatic dimethacrylates, hydrophobic aliphatic dimethacrylates, Camphorquinone	66 vol%, 78wt% Silanated barium glass (0.7 mm) and pre-polymerized organic filler
Clearfil AP-X	KURARAY		Bis-GMA, TEGDMA	Barium glass, silica (0.1-15 µm)
Clearfil Photo-Posterior (PP)	KURARAY <sup>VI</sup>		BisGMA, TEGDMA, UDMA	Silanated silica, barium glass, colloidal silica Particle size (0.04–20 mm) average = 4mm
Clearfil Majesty	KURARAY MEDICAL <sup>vii</sup>		Bis-GMA, TEGDMA, Hydrophobic aromatic dimethacrylate	78 wt%, 66 vol% silanated barium glass filler, pre-polymerized organic filler Micro-filler ( 1.5 µm ), Nano -filler ( 20 nm )
Tetric Evo Ceram	VIVADENT <sup>V,VII</sup>	Nanohybrid	BisGMA, Bis EMA, UDMA, DMDMA (decamethylendimethacrylate), additives, catalysts, stabilizers,	Barium glass, spherical mixed oxide, YbF3 prepolymers (82–84 wt%) 40–3000 nm, mean 550nm
Tetric N Ceram	VIVADENT		Phosphonic acid acrylate, HEMA, Bis-GMA, UDMA, ethanol, catalyst, stabilizers	55–57 vol%, 79wt% Barium glass, ytterbium trifluoride, mixed oxide, and copolymers (between 40–3000 nm)
Gradia Direct	GC <sup>VIII</sup>		Dimethacrylate co-monomers, UDMA, camphorquinone and amine catalysts, and pigments	65 vol%, 77wt% F-Al-Si (0.85 mm), prepolymerized filler, and silica (0.85 mm)
Kalore	GC <sup>XIV, VIII</sup>		UDMA (DuPont), DMA, UDMA, (Technology from Dupont),	69 vol% Prepolymer (400nm SrO <sub>2</sub> and 100nm lanthanoid fluoride), F-Al-silicate (700 nm), Sr-Ba-glass (700 nm), SiO <sub>2</sub> (16 nm)
Venus Diamond	HERAEUS KULZER <sup>ix, x</sup>	Nanohybrid	TCD-DI-HEA {2-propenoic acid, (octahydro-4,7 methano-1H-indene-5-diyl) bis(methyleneiminocarbonyloxy-2,1-ethanediyl) Ester}, UDMA	barium aluminum fluoride glass, highly discrete nanoparticles; (0.005 – 20 µm) [82 wt.%, 64 vol.%]
Synergy D6	COLTÈNE/WH ALEDENT <sup>xI</sup>	Nanohybrid	Bis GMA, Bis EMA, TEGDMA	Pre-polymerized fillers, glass fillers, nanofillers – range of particle size: 20–2500 nm – average particle size: 600 nm (80 wt%)
Miris 2	COLTÈNE/WH ALEDENT	Nanohybrid	Bis-GMA, TEGDMA, UDMA S2b	(65 vol.%, 80 wt%) silanized barium glass, amorphous silica (0.02–2.5 µm)
ELS	SAREMCO		Bis-GMA, Bis-EMA	(50 vol%) Average particle size : 0.07–2.6 µm

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<b>Heliomolar</b>	IVOCLAR	Nanohybrid	BisGMA, UDMA, decandiol dimethacrylate	PPRF (prépolymerized filler, highly dispersed dioxide, YbF <sub>3</sub> )
N'Durance	SEPTODONT	Nanohybrid	Bis-EMA, UDMA, dicarbamate dimethacrylate dimer acid	Ytterbium fluoride (silanated), barium glass (silanated), silica; (range of particle size, 0.01 – 0.5 μ m) [80 wt%, 65 vol.%]
<b>Simile</b>	PENTRON CLINICAL <sup>3</sup>	Nanohybrid	PCBis-GMA, Bis-GMA, UDMA, HDDMA	Barium boro-silicate glass, silica filler,zirconium silicate;( 0.02 - 0,7 μ m) (75 wt.%, 68 vol.%)
<b>Charisma</b>	HERAEUS KULZER <sup>xii</sup>		Bis-GMA, TEGDMA	78wt%, 61vol%
<b>Beautifil II</b>	SHOFU DENTAL <sup>xiii</sup>		Bis-GMA, TEGDMA	Filler: 83.3 wt% (68.6 vol%) multi-functional glass and S-PRG filler based on fluoroboralfuminosilicate glass Particle size range: 0.01–4.0 ~ m (mean 0.8 ~ m)
<b>Estetite sigma quick</b>	TOKUYAMA DENTAL <sup>xiv</sup>		Bis-GMA, TEGDMA, Photo initiators	Silica/zirconia filler, composite filler (84wt%, 71vol%)
<b>SureFil</b>	Dentsply <sup>IV</sup>		Modified Bis-GMA, urethane resin	Silanized barium, borosilicate-aluminium Filler volume: 65% Filler weight: 82%
<b>Bisfil 2B</b>	Bisco <sup>IV, XV</sup>		Bis-GMA, BIS-EMA, TEGDMA	Silica, glass frit, Filler weight: 75%
<b>Protocell-nano</b>	VOCO <sup>V</sup>	Nanohybrid	Bis-GMA, TEGDMA, UDMA 18 wt%	Strontium aluminium borosilicate: 0.6m SiO <sub>2</sub> nanoparticles: 20 nm

# Bibliographie

- i Alternative methods for determining shrinkage in restorative resin composites
- ii HPLC Analysis of Eluted Monomers from Two Composite Resins Cured with LED and Halogen Curing Lights. *Journal of Biomedical Materials Research Part B: Applied Biomaterials*. 2008
- iii Relationship between the degree of conversion, solubility and salivary sorption of a hybrid and a nanofilled resin composite: influence of the light-activation mode. *J Appl Oral Sci.* 2008;16(2):161-6
- iv Effect of light-curing units and activation mode on polymerization shrinkage and shrinkage stress of composite resins. *J Appl Oral Sci.* 2008;16(1):35-42.
- v Effect of food/oral-simulating liquids on dynamic mechanical thermal properties of dental nanohybrid light-cured resin composites. *Dental materials* 29 ( 2013 ) 842–850.
- vi Initial fracture resistance and curing temperature rise of ten contemporary resin-based composites with increasing radiant exposure. *Journal of dentistry* 41 (2013) 455-463.
- vii Color Changes of Dental Resin Composites before and after Polymerization and Storage in Water. *Journal of Esthetic and Restorative Dentistry* V 23 • No 3 • 179–188 • 2011
- viii Polymerization profile analysis of resin composite dental restorative materials in real time. *Journal of dentistry* 40 (2012) 64-70.
- ix Polymerization stresses in low-shrinkage dental resin composites measured by crack analysis. *Dental material* 28 (2012) 143-149.
- x Depth of cure and mechanical properties of nano-hybrid resin-based composites with novel and conventional matrix formulation. *Clin Oral Invest* (2012) 16:1425 – 1434.
- xi Investigating filler morphology and mechanical properties of new low-shrinkage resin composite types. *Journal of Oral Rehabilitation* 2010 37; 364–376.
- xii Effect of preheating on the film thickness of contemporary composite restorative materials. *Journal of Dental Sciences* (2014) 9, 313 - 319.
- xiii Translucency, opalescence and light transmission characteristics of light-cured resin composites. *Dental materials* 26 ( 2010 ) 1090–1097.
- xiv Vertical and horizontal polymerization shrinkage in composite restorations. *Dental materials* 30 (2014) 189 – 198.
- xv Bisfil 2B-MSDS.

# Composition globale de la plupart des composites dentaires

Products	Manufacturer	Core build-up	
		Matrix	Composition Fillers
Rely X ARC	(3M ESPE) <sup>i</sup>	TEGDMA, Bis GMA, functionalized dimethacrylate polymer	Silane-treated silica, Silane-treated ceramic
LuxaCore -Dual	DMG <sup>ii</sup>	Aliphatic dimethacrylate, Bis GMA	Barium glass and pyrogenic. silica, filler 72 wt%, 49 vol%, filler size: 0.02 to 4 µm
Para Core (PC)	COLTÈNE/ WHALEDENT	BisGMA, TEGDMA, UDMA;	Fluoride, barium glass, amorphous silica (68 wt%, 0.1-5 mm)
Build-It FR (Fiber reinforced core)	JENERIC PENTRON <sup>iii ix</sup>	Bis-GMA, UDMA, HDDMA	silane treated bariumborosilicate glass fillers, chopped glass fibers, pigments with initiators, stabilizers and UV absorber
Clearfil DC Core	KURARAY MEDICAL <sup>iv</sup>	Bis-GMA, TEGDMA	Silanated colloidal silica, barium glass, d,l-camphorquinone, benzoyl peroxide, N,N-diethanol-p-toluidine 74wt%
Clearfil DC Core Automix One [DC]	Kuraray Noritake Dental <sup>xii</sup>	Bis-GMA, TEGDMA	Silanated barium glass filler, silanated silica, Bis-GMA, TEGDMA, CQ, chemical catalyst, accelerators, Filler loading: (74 wt%) 52 vol% The particle size of inorganic fillers ranges from 0.04 lm to 23 lm
FibreKor	PENTRON	Bis-GMA, UDMA, HDDMA	30.8% volume of glass fiber, 16.2% volume of filler, 53%
Clearfil DC Core Plus,	KURARAY	Bis-GMA, hydrophilic aliphatic dimethacrylate, hydrophobic aliphatic dimethacrylate, hydrophobic aromatic dimethacrylate, TEGDMA	Glass filler, silanized colloidal silica, initiator, photo-initiator, pigments silanized Ba glass filler, Al <sub>2</sub> O <sub>3</sub> filler, photo-accelerator, accelerator
Core Paste	DENT MAT <sup>ix</sup>	methacrylate resin	Glass fillers
Rebilda DC	VOCO <sup>v</sup>	Bis-GMA, UDMA, DDDMA	BHT, BPO, CQ, amine, silica, barium borosilicate glass ceramic, 71 wt%
Grandio core DC	VOCO <sup>vi</sup>	TEGDMA, Bis-GMA, UDMA	Silica/Ba glass ceramics 0.05–5 µm, 77wt%
Rock Core	DANVILLE MATERIALS <sup>x</sup>	Bis-GMA based resin.	Barium glass 0.002 to 40µm 69%, silica 3%
CosmeCore	COSMEDENT <sup>vii</sup>	BisGMA, UEDMA, Diacrylate	Barium aluminum boron silicate glass, silica fume (70%wt), BPO
Fluorocore	CAULK <sup>i,viii</sup>	UDMA	Barium boron fluoro-alumino silicate glass, Benzoyl peroxide, Aluminum Oxide.
Mirafit	Hager & Werken	Bis-GMA, UDMA, HDDMA <sup>ix</sup>	silane treated bariumborosilicate, glass fibers, fluoride, pigments with initiators, stabilizers and UV absorber. NC% wt.; vol. inorganic filler
Grandio Core DC	VOCO <sup>x, xi</sup>	TEGDMA Bis-GMA, UDMA resins	Silica/Ba-glass ceramics (77%, wt). Amines, benzoyl peroxide, BHT)
Unifil core EM	GC <sup>xii</sup>	UDMA, di-methacrylate	Fluoro-aluminosilicate glass, photo/chemical initiators, chemical catalyst
Dentocore	ITENA	TEGDMA	Co-initiator, Photoinitiator, Fumed Silica

# Bibliographie

- i Effect of curing mode on the hardness of dual-cured composite resin core build-up materials. *Braz Oral Res.* 2010 Apr-Jun;24(2):245-9.
- ii Effect of sodium hypochlorite contamination on microhardness of dental core build-up materials. *Dental Materials Journal* 2010; 29(4): 469–474.
- iii Influence of Polymerization Mode on Degree of Conversion and Micropush-out Bond Strength of Resin Core Systems Using Different Adhesive Systems. *Dental Materials Journal* 2008; 27(3): 376 – 385.
- iv Effect of viscosity of dual-cure luting resin composite core materials on bond strength to fiber posts with various surface treatments. *Journal of Dental Sciences* (2014) 9, 320e327.
- v Influence of light-curing protocols on polymerization shrinkage and shrinkage force of a dual-cured core build-up resin composite. *Eur J Oral Sci* 2010; 118: 423–429.
- vi Effect of self and dual-curing on degree of conversion and crosslink density of dual-cure core build-up materials. *journal of prosthodontic research*, article in press.
- vii Comparison of Mechanical Properties of Five Commercial Dental Core Build-Up Materials - See more at: <https://www.dentalaegis.com/cced/2013/01/comparison-of-mechanical-properties-of-five-commercial-dental-core-build-up-materials#sthash.BjR3pDBm.dpuf>.
- viii The effect of thermocycling on the fracture toughness and hardness of core buildup materials. *The journal of prosthetic dentistry*. volume 86 number 5
- ix Influence of inorganic filler content on the radiopacity of dental resin cements. *Dental Materials Journal* 2012; 31(2): 266–272.
- x Influence of chemical surface treatments on adhesion of fiber posts to composite resin core materials. *dental materials* 2 9 ( 2 0 1 3 ) 550–558.
- xi Build-Up of a Resin Composite Core in a Fiber-Reinforced Post by a 2.78 µm-Pulsed Laser Treatment. *Journal of Laser Micro/Nanoengineering* Vol. 10, No. 2, 2015.
- xii Bond performance of “Touch and Cure” adhesives on resin core systems. *Dental Materials Journal* 2016; 35(3): 386–391.

# Composition globale de la plupart des ciments résines dentaires

Self adhesive resin cements				
Products	Manufacturer	Compositions		
		Adhesion monomers	Matrix	Fillers
Rely X U200	3M <sup>i</sup>	Methacrylate monomers containing phosphoric acid	Methacrylate monomers, initiator components, stabilizers, additives	Alkaline fillers, silanated fillers, , stabilizers, pigments, zirconia/silica fillers, clicker delivery system
Maxcem Elite	KERR <sup>vi, ix ii iii</sup>	GPDM monomer	Di-, and tri-functional methacrylate monomers, redox initiator system, camphorquinone-based photoinitiator	Barium aluminosilicate glass, fluoroaluminosilicate glass, nano-ytterbium fluoride, nanosilica (filler = 67 wt%, avg. 3µm – orig. Maxcem)
Panavia F 2	KURARAY <sup>iv</sup>	10-MDP	Hydrophobic aromatic dimethacrylate; Hydrophobic aliphatic dimethacrylate; Hydrophilic aliphatic dimethacrylate; N,N' -diethanol-P-toluidine, sodium 2,4,6-trisopropyl benzene sulfonate	Sodium fluoride, silanated barium glass filler; accelerators; Pigments; silanated colloidal silica; I-Camphorquinone; Catalysts; Initiators.
BisCem	BISCO <sup>vi, v</sup>	Bis Hydroxyethyl Methacrylate) dhosphate	BisGMA, TEGDMA, EDMAB, dihydroxyethyl-p-toluidine, CQ, MEHQ, BHT, benzoyl peroxide	Dental Glass silica.
Bistite II	TOKUYAMA	MAC-10	Dimethacrylate, initiator	Silica Zirconia
G-Cem	GC <sup>vi ix vii</sup>	4-MET, phosphoric acid ester monomer	UDMA, dimethacrylate,water	fluoroaluminosilicate glass, initiator, pigment (filler = 71wt%, avg. 4 µm), silica powder, initiator, stabiliser
RelyX Unicem	3M <sup>vi, viii</sup>	methacrylated phosphoric ester	Dimethacrylate (bis-GMA/TEGDMA ), acetate, stabiliser, initiator	glass, silica, calcium hydroxide, pigment, substituted pyrimidine, peroxy compound,initiator (filler = 72 wt%; avg. <9µm)
Breeze	PENTRON <sup>ix</sup>	4-MET resins	Mixture of Bis-GMA, UDMA, TEGDMA, HEMA,	silane-treated barium borosilicate glasses, silica with initiators, stabilizers and UV absorber, organic and/or inorganic pigments, opacifiers
Total Cem	ITENA <sup>x</sup>	4-MET resins	Urethane dimethacrylate Oligomer, TEGDMA	Barium aluminoborosilicate glass, BPO, Photoinitiators, Co-initiator
Clearfil SA cement	KURARAY <sup>xi xii</sup>	10-MDP	Bis-GMA, TEGDMA, hydrophobic aromatic dimethacrylate,	silanated barium glass filler, silanated colloidal silica, di-camphorquinone, benzoyl peroxide, Initiator surface treated sodium fluoride, accelerators, pigments
Bifix SE	VOCO <sup>vi,xiii</sup>	Acidic adhesive monomers,	Bis-GMA, UDMA, GDMA, Hydroxypropyl methacrylate	initiators, stabilisers, glass fillers, aerosol silica (filler = 70 wt%; 61 vol%; avg. 2 µm)
Monocem	Shofu		Mono-, di- and multi-functional acrylate resins, dual-initiators	fillers (filler = 60 wt%)

# Composition globale de la plupart des ciments résines dentaires

Smart Cem 2	Dentsply <sup>vi,xiv,xv</sup>	phosphoric acid modified acrylate resin	UDMA, Di- and Tri-methacrylate resins	fluoroaluminosilicate glass initiators, accelerators, stabilisers, butylated hydroxyl toluene, titanium dioxide, hydrophobic silica (filler = 69 wt%; 46 vol%; avg. 3–8 lm glass and 16 nm aerosol silica)
Speed Cem	Ivoclar <sup>vii</sup>	Dimethacrylates, methacrylated phosphoric esters	Copolymers,	initiators, catalysts, stabilisers barium glass, ytterbium trifluoride, high dispersed silica (filler = 40 vol%; size 0.1–7 lm)
Multilink Sprint	Ivoclar <sup>vii</sup>	Acid monomers	Dimethacrylate monomers	barium glass fillers, ytterbium trifluoride, silicon dioxide (filler = 57 wt%; avg. 5 lm)
Embrace WetBond	Pulpdent <sup>ix</sup>	Resin acid-integrating network (RAIN).	Di-, tri-, and multi-functional acrylate monomers into a hydrophilic,	Barium, glass, ytterbium trifluoride, inert minerals, amorphous silica,
RelyX TM Unicem 2 Automix	3M <sup>xvi</sup>	Phosphoric acid modified ethacrylate monomers	bi-functional methacrylate,	70%wt inorganic fillers of <12.5µm grain size, silanated Calcium ions, alumina, strontium, fluoride fillers, alkaline amines initiator
RelyX TM U100	3M	Methacrylate monomers containing Phosphoric acid groups,	Methacrylate monomers	70%wt inorganic fillers of <12.5µm grain size, silanated Calcium ions, alumina, strontium, fluoride fillers, initiator components, stabilizers, pigments
SeT	SDI <sup>xvii</sup>	Acidic monomer,	UDMA,	F-Al-Si glass particles
G-Luting	GC <sup>xviii</sup>	Phosphoric ester monomer	UDMA, dimethacrylate	fluoro-alumino-silicate glass, silicon dioxide, initiator
BeautiCem SA	SHOFU <sup>xix, xx</sup>	Carboxylic acid and Phosphonate monomers	UDMA, HEMA	Fluoro-alumino-silicate glass, Zirconium silicate filler (amorphas), initiator.

# Bibliographie

- i The effect of polymerization mode on monomer conversion, free radical entrapment, and interaction with hydroxyapatite of commercial self-adhesive cements. *Journal of the mechanical behavior of biomedical materials* 46 ( 2015 ) 83 – 92.
- ii Kinetics of polymerization and contraction stress development in self-adhesive resin cements. *Dental materials*. 28 (2012) 1032-1039
- iii Maxcem Elite™ Self-etch/Self-adhesive Resin Cement. **MSDS**
- iv Adhesion of 10-MDP containing resin cements to dentin with and without the etch-and-rinse technique. *J Adv Prosthodont*, 2013;5:226-33
- v Water interaction with dental luting cements by means of sorption and solubility. *Braz Dent Sci* 2012
- vi Self-adhesive resin cements – chemistry, properties and clinical considerations. *Journal of Oral Rehabilitation* 2011 38; 295–314
- vii Bond durability of self-adhesive composite cements to dentine. *Journal of dentistry* 41;2013,908-917.
- viii Dentin treatment effects on the bonding performance of self-adhesive resin cements. *Eur J Oral Sci* 2010; 118: 80–86.
- ix Self-adhesive cements and all ceramic crowns: a review. *IAJD* Vol. 5 – Issue 2.
- x ITENA, TotalCem. **MSDS**.
- xi Effect of different mechanical cleansing protocols of dentin for recementation procedures on micro-shear bond strength of conventional and self-adhesive resin cements. *International Journal of Adhesion & Adhesives* 41 (2013) 107–112.
- xii Adhesion of 10-MDP containing resin cements to dentin with and without the etch and rinse technique *J Adv Prosthodont* 2013;5:226-33.
- xiii Effect of Different Silane-Containing Solutions on Glass-Ceramic/ Cement Bonding Interacting with Dual-Cure Resin Cements. *J. Dent. Sc.* | No.16: 87-105, 2014. ISSN:1659-1046.
- xiv Bond strength of self-adhesive resin cements to tooth structure. *The Saudi Dental Journal* (2015)
- xv Shear bond strength of self-adhesive resin cements to base metal alloy. Copyright 2014 by *the Editorial Council for The Journal of Prosthetic Dentistry*.V3 Issu 5.

# Bibliographie

- xvi Sorption and solubility characteristics of self-adhesive resin cements. *Dental materials* 28 (2012) 187-198.
- xvii Dual and Self-curing Potential of Self-adhesive Resin Cements as Thin Films. *Operative Dentistry*, 2011, 36-6, 635-642.
- xviii Influence of temporary cement contamination on the surface free energy and dentine bond strength of self-adhesive cements. *Journal of dentistry* 40 (2012) 131-138.
- xix BeutiCem SA. *MSDS*.
- xx Mechanical Properties and Sliding-impact Wear Resistance of Self-adhesive Resin Cements. *Operative Dentistry* · February 2016.

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