Heraeus

i|BOND™
Gluma Inside

The first "All-in-One"-Adhesive

Compendium

Heraeus Kulzer

Introduction

The increasing demand for tooth-coloured filling materials and the aesthetic advantages they offer has led to intensive research and development into composites over the past few decades. Modern restoration materials can now imitate original tooth structure remarkably well, while achieving the aim of providing minimally invasive treatment.

The use of these resin materials does, however, make pretreatment with an adhesive essential. A reliable, gap-free, durable bond between the composite and the tooth structure can only be attained using an adhesive.

Adhesion to the enamel

A simple method has been used for a number of decades to produce effective, gap-free, durable adhesion. A minute amount of mineral structure is removed using acid (an etching time of 20 – 30s is required, if phosphoric acid is used); this roughens the enamel surface and increases the surface area ten to twenty times. The etched contours this creates are penetrated by a low-viscosity adhesive, which provides micromechanical retention by means of villi or resin tags when polymerised. This layer forms the bonding zone to the composite.

Adhesion to the dentine

The reduction of the tooth with a rotary instrument leaves a smear layer on the dentine surface. Though this film cannot be wiped or rinsed off, the bond is not stable enough to enable permanent adhesion of a restoration.

The dentine also has to be conditioned to create an adequate bond, i.e. the surface is prepared for applying the bonder solution. Acids, which remove or at least modify the smear layer, are also used for this procedure to allow adhesion to the dentine matrix underneath (an etching time of only 15 – 20s is needed, if phosphoric acid is used!). This demineralises the dentine surface and exposes the intertubular and peritubular loose woven collagen. Primer and adhesive (comprising one or more components depending on the generation) penetrate this sponge-like structure and form a hybrid layer after polymerisation to create a bond between the dentine and composite.

What are the advantages of self-conditioning adhesives compared with conventional products?

One advantage of the total-etch technique, when used correctly, is that it is capable of producing optimum hybridisation of the dentine, though it has the disadvantage of being technique sensitive. Overetching, and improper drying are two of the main causes of postoperative problems when using total-etch solutions with phosphoric acid gels. Therefore, a logical step was to develop adhesive solutions, which help prevent the dentine from being overetched or improperly dried.

This seems to be a most reasonable approach to the reduction in post-operative problems. Self-conditioning adhesives now facilitate the treatment success in many areas of dentistry – including pediatrics and for class V restorations.

In systems with phosphoric acid gel conditioning, hybridisation has to be completed after demineralisation as a separate working stage so that all the microcavities created are completely filled by the primer and by the adhesive (or by the primer/adhesive in Type 2 adhesives).

Generation	3	4	5	6	6	7
Type of adhäsive	1	1	2	3	4	4
Number of working stages	3–4	3	2	2	1	1
Type of conditioning	Selective Ena Etching	Total-etch (Phosphoric acid)	Total-Etch (Phosphoric acid)	Self-etching	Self-etching	Self-etching
System component	Multi-bottle system	Multi-bottle system	Single-bottle system	Multi-bottle system	Two-component system	All-in-one no mixing
Stage 1	Etching (Phosphoric acid) Enamel	Etching (Phosphoric acid) Enamel + dentine	Etching (Phosphoric) acid) Enamel + dentine	Self-conditioning Primer	All-in-one one-step application after mxing the two components	
Stage 2	Priming	Priming	Priming/ Bonding	Bonding		
Stage 3	Bonding	Bonding	Bonding			
Product example		Gluma Solid Bond	Gluma Comfort Bond + Desensitizer			iBOND Gluma Inside

Fig. 1: Different generations of bonding agents

Self-conditioning adhesive systems (Type 3 and 4) contain self-etching primers, which eliminates the need for separate etching of the enamel and dentine with phosphoric acid. The smear layer is dissolved or rendered penetrable, the enamel and dentine are conditioned and an adhesive layer is formed in one step. Consequently with these systems, the microcavities and nanocavities produced by conditioning are always filled and do not therefore lead to nanoleakage. Demineralisation corresponds better to the depth of penetration of the monomers. There is also no possibility of the collagen fiber matrix collapsing due to overdrying; this type of collapsed (blocked) collagen matrix is a barrier to subsequent penetration of adhesive into the demineralised dentine.

After rinsing and drying the phosphoric acid, operators using conventional adhesive systems must dry the dentine to suit the solvent contained in the system's primer. While solvents that contain water can be used as a rewetting agent for "regenerating" an overdried, i.e. collapsed, collagen matrix and compensate in this way for overdrying. However, adhesives which contain acetone or ethanol, when used in the total-etch technique, requires moist dentine.

The solvent has to be removed later by carefully evaporating it with an air jet, since any residual solvent will greatly inhibit polymerisation.

Advantages of self-conditioning Adhesives

- Reduces sources of errors
- No overetching or overdrying
- Woven collagen fibers do not collapse
- Corresponding depth of demineralisation and penetration
- Reduces hypersensitivity

iBond – 7th generation all-in one adhesive system

iBond is one of the latest and most innovative products in the development of dental adhesives. It compliments and expands the range of other Heraeus Kulzer bonding adhesives, such as Gluma Solid Bond and Gluma Confort Bond (+ Desensitizer), and is based on materials that are clinically proven in dentistry for many years. In contrast to conventional total-etch-systems, conditioning and monomer infiltration are completed simultaneously, eliminating the most of the risk of leaving partially exposed collagen fibers on the floor of the hybrid layer. It is now generally accepted that with self etching adhesives, the resin-impregnated layer (hybrid layer) corresponds more closely and completely to the depth of etching and demineralisation.

Composition

Components …	…and their effect
■ UDMA	• Helps forms a film, cross-links • Solubilizes the smear layer
■ 4-META	• Dissolves the mineral component of the enamel and dentin tissue • Wetting agent • Bonds to collagen via a hydrogen bridge bond • Bonds to the calcium of the hydroxylapatite via a chelate bond
■ Glutardialdehyde	• Desensitiser • Desinfectant • Cross-linking of collagen fibers
■ Acetone	• Solvent for monomers • Hydrophilic carrier for monomers
■ Water	• Hydrolysis of 4-META • Water supply for etching
■ Photoinitiators	• Polymerises the monomers of iBond
■ Stabilisers	

Recommended Indications for use:

- Direct composite restorations – anterior and posterior when applied to prepared normal enamel and dentin
- Desensitising hypersensitive areas of teeth
- Sealing of cavities being restored with dental amalgam
- ❑ Separate etching is required, when used on unprepared enamel or schlerotic dentin

Contraindications for use:

- Should not used with self cured composite materials
- Should not be used for the cementation of opaque, non light conducting indirect restorations
- ❑ Special attention has to be paid to a sufficient light curing of the luting cement by luting translucent, light conducting, indirect restorations

Mode of action

Self-conditioning

iBond self-conditioning adhesive is based largely on the acidic actions of 4-META. In an aqueous solution, some of the 4-META dissociates and releases acidic H^+ ions. When applied to the tooth, these acidic H^+ ions condition the enamel and dentin while the 4-META bonds to the calcium of the hydroxylapatite. The hydroxylapatite that is dissolved during this process neutralises the acid so that the etching effect gradually slows down and stops.

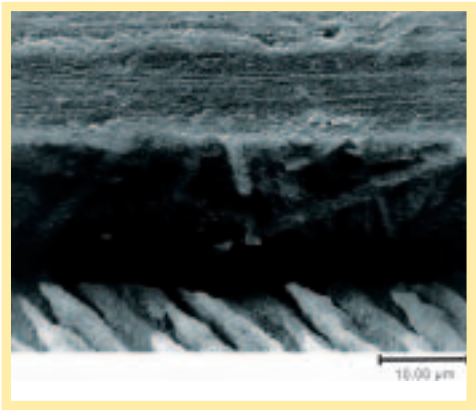
Material technology

As iBond etches, primes, bonds and desensitises the enamel and dentine simultaneously, it reduces the number of working steps and minimizes the possibility of errors.

iBond produces a bonding layer of approx. 5 – 10 µm with a hybrid layer of approx. 0.5 µm. Studies have proven that this layer thickness is suitable for a permanent bond, as there appears to be no correlation between the thickness of the hybrid layer and bonding strength. The interdiffusion zone of resin and dentine exhibits the same amount of penetration. The resin completely surrounds the collagen fibers.

The residual moisture content of the prepared enamel and dentine is of secondary importance with iBond, as it can be applied equally well to moist or dry tooth structure.

The integrated active ingredient of Gluma Desensitizer promotes effective, long-term reduction of postoperative sensitivity. The desensitising agent penetrates directly into the dentinal tubules producing coagulation in the depths of the tubules and stops osmotic movement of the tubular fluid through the formation of protein septa.



A 5.000 x magnification shows the 0.5 µm thick hybrid layer and the 5 – 10 µm thick bonding layer.

Application overview

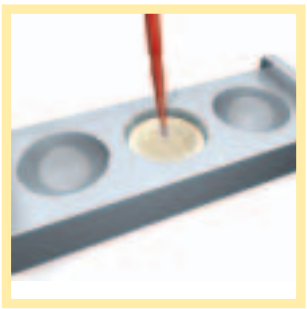
The bottle is used here to illustrate the application of iBond.
The working steps are the same when using iBond single dose.

1.

2.

Before use, bring iBond back to room temperature, shake bottle and dispense *(Fig. 1+2).*

3.



iBond is removed from the container using a micro-brush applicator and applied in 3 successive layers to the prepared enamel and dentine, beginning first at the enamel margins and then moving to the deeper dentin of the cavity

4.

The applicator is dipped in iBond again before applying each layer. There is no need to dry off the applied layers with air or wait between applying successive layers *(Fig. 3, 4, 5).*

5.

6.

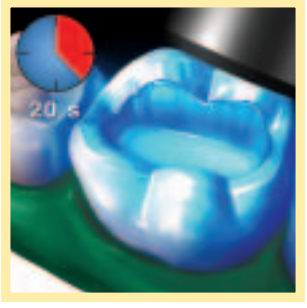
Following application allow iBond to take effect for 30 seconds *(Fig. 6).*

7.

8.

Carefully dry the solvent with a gentle stream of dry air until there is no visible undulating movement. Then dry it for a few seconds longer with a strong jet of air *(Fig. 7+8).*
Clinically evaluate at this point to assure the presence of a uniform, shiny, homogeneous adhesive layer.

9.

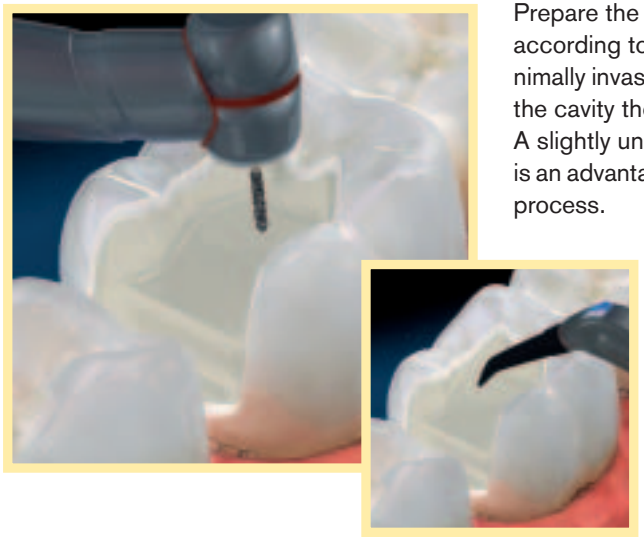


Polymerise iBond with a conventional halogen curing light for 20 seconds *(Fig. 10).*

iBond in Class I and II

Self-conditioning adhesive technique – User and background information

Step 1

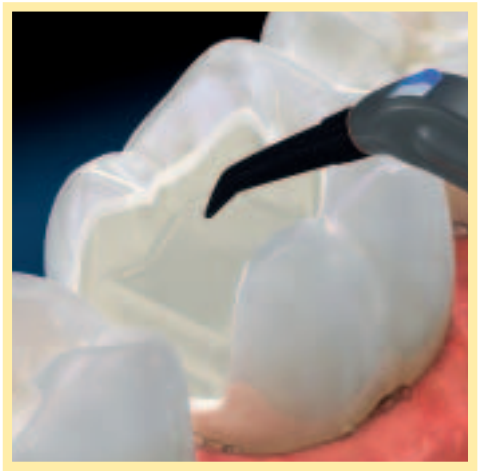


Prepare the enamel and dentine surfaces according to the accepted principles for minimally invasive adhesive dentistry, and rinse the cavity thoroughly with the water spray. A slightly uneven or bevelled cavity margin is an advantage for the subsequent bonding process.

Background information:
Loosened particles that would partially block the etching effect of the self-conditioning adhesive, which may reduce the demineralisation effective-ness and depth are remo-ved by rinsing the cavity.

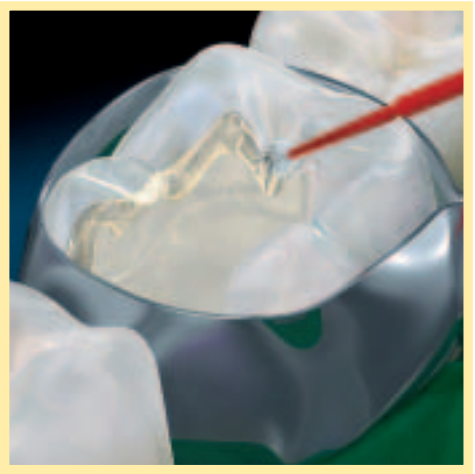
Step 2

After rinsing, dry the prepared enamel and dentine surfaces enough so that there is no pooling of water on the cavity surfaces. The surfaces do not require excessive drying. iBond can tolerate a moist or dry surface. Proper isolation techniques (e.g. rubber dam) should be used.



Background information:
If iBond is applied directly onto pools of water, there is phase separation between the monomeric phase and the aqueous acid phase before the acid can penetrate the dentine. The aqueous phase itself brings very few multifunctional, cross-linking groups into the dentine and the 4-META conditioned groups, which were loosened in the monomeric phase, remain on the surface. Phase separation due to excess water ultimately reduces the amount of cross-linking.

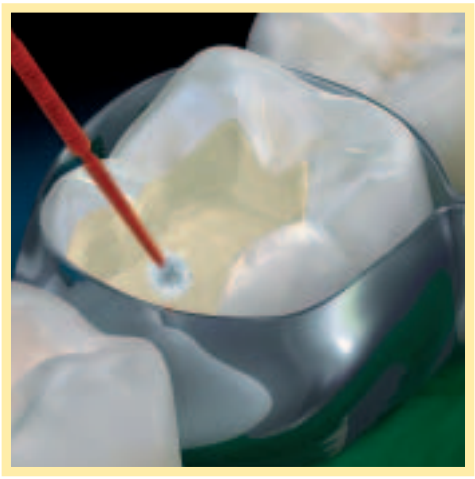
Step 3a



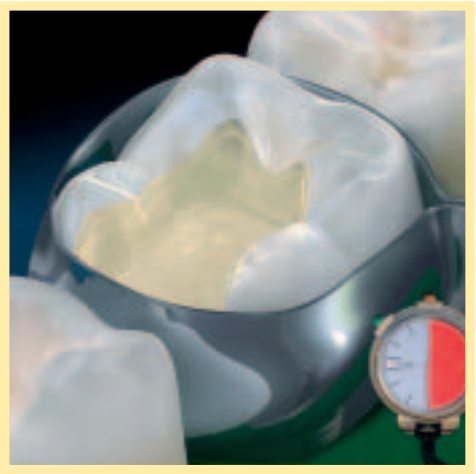
Apply three consecutive and copious layers of iBond to the enamel and dentine from the coronal towards the apical beginning first at the cavity margins in the enamel.
The applicator should be sufficiently saturated with iBond or dipped in iBond several times during application to ensure enough adhesive and therefore adequate acid is available for etching the enamel and dentine.

Background information:
Only small amounts of the functional components (cross-linking monomers, 4-META) are included in iBond to ensure a longer shelf life. iBond also contains a certain proportion of solvents (water, acetone), which gives it a low viscosity. When it is applied to vertical cavity walls, its low viscosity allows it to run easily down the vertical walls and pool in the deeper parts of the cavity.
For this reason it is important that iBond is applied first to the edges of the cavity, then carefully and evenly distributed to cover the whole area of the margins so that there is an adequate supply of material and acid to ensure proper etching, monomer infiltration and hybridisation.
Lightly rubbing the adhesive when applying it and during the dwell time helps to increase the contact between the acidic groups and the tooth structure and produces a better, more uniform bond strength to the vertical walls and the cavity margins.

Step 3b



Step 4

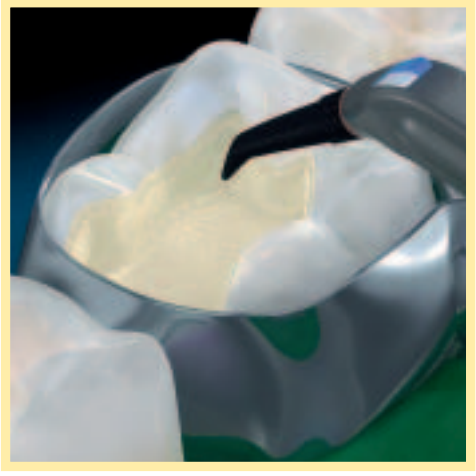


Then wait for 30 seconds to allow the hydroxylapatite in the enamel and dentin to dissolve, the acid effect to neutralise during penetration into the tooth structure and the collagen fibres to be hybridised by the monomers.

Background information:
If the acid (4-META) is not given sufficient time to react, it cannot dissolve the tooth structure or will not dissolve it sufficiently. Consequently there is too little space for the monomers to penetrate. Acid and solvents (water, acetone) only superficially penetrate the tooth structure. There is no hybridisation between the collagen and monomers.

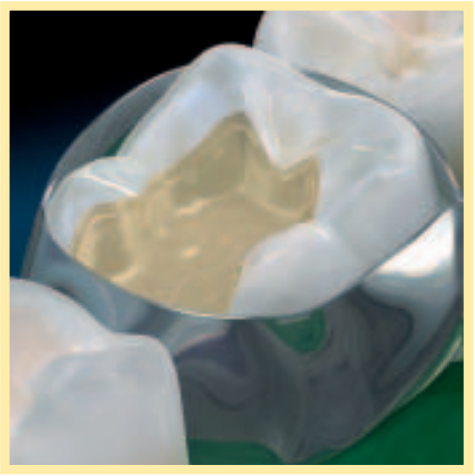
Step 5

The monomer film that is produced after a careful initial drying still contains some solvent.
This film should then be thoroughly dried with a strong jet of air for a few seconds to evaporate the residual water.



Background information:
Water greatly inhibits polymerisation and proper bonding to the composite layer. If water is not properly removed, the degree of polymerisation is reduced and the density of the polymer matrix is low. If water molecules remain dispersed in the monomer layer, there is phase separation during polymerisation.
The existing accumulations of water or water produced during polymerisation in the polymer are called water trees, water blisters and/or nanostructured water channels. These can expand and weaken the adhesive layer.
It is therefore very important to eliminate as much water as possible.

Step 6

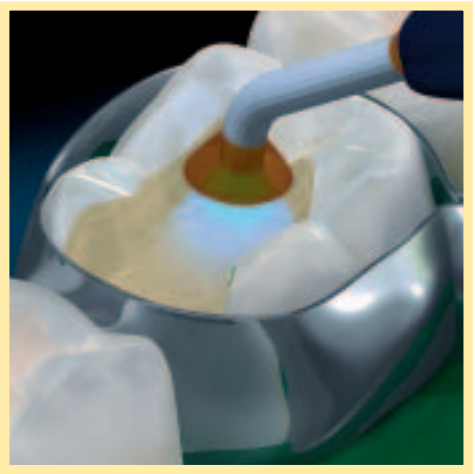


Quality control of the applied and jet air-dried iBond film:

You can judge that a sufficient amount of iBond has been applied and the material has not been thinned out too much when the layer appears completely homogeneous (corners/edges!) and shiny.
The edges of the enamel and cavosurface margins in particular must have this moist, shiny appearance.

Background information:
If there are dry, mat areas visible this is an indication that the adhesive film is incomplete (too little adhesive applied, or material has been overdried). Complete wetting between the adhesive layer and composite will not be ideal in these areas. This tends to produce an inhomogeneous bond, especially if a composite is used that is based on a very hydrophobic matrix system. If the cavity surface does not appear shiny, apply additional coats of iBond and proceed as described above.

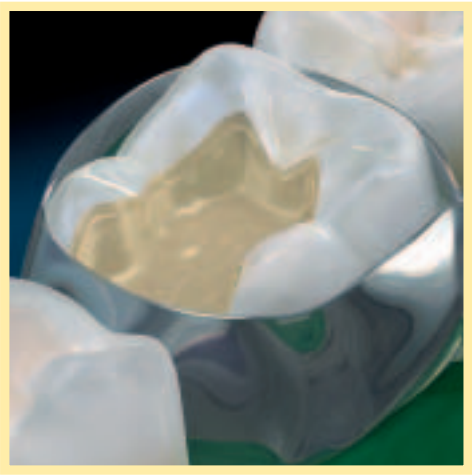
Step 7



Light cure for 20 seconds.
This is recommended for standard halogen lamps. The polymerisation time should be reduced to 10 seconds with high-powered halogen lamps (>1000 mW/cm^2) or plasma lamps to prevent the risk of thermal damage to the pulp.
When using first generation low output LED lamps, the polymerisation time should be increased by approx. 50 %, while the polymerisation times for second-generation LED lamps are roughly the same as those for standard halogen lamps.

Background information:
The polymerisation time depends on the size and depth of the cavity. In most cases the recommended exposure time is sufficient.
Some high-powered curing units carry a risk of thermal damage to the pulp with extremely long exposures. There is also the risk of inadequate polymerisation when using curing lamps (bulbs) that are too weak.
Ensure that curing light is checked regularly for adequate output and that it is applied uniformly with adequate exposure to all areas. Be sure to pay particular attention when you treat narrow cavities or deep approximal boxes.
Large cavities often require longer polymerisation times, as all the bonded surfaces cannot be accessed in one polymerisation cycle.

Step 8



Applying composite to the adhesive prepared tooth structure.

Background information:

Uniform adaptation of the composite to the oxygen inhibition layer of the polymerised adhesive is of fundamental importance for excellent bonding between the two components. A lack of uniformity can lead to gap formation and a reduced overall bond strength.

It is also important to work with a composite which is neither too dry or too sticky. Dry composites are difficult to adapt to the cavity walls and subsequent layers. Sticky composites on the other hand may come away easily from previously placed layers or the cavity walls during adaptation, due to adherence to the placement instrument.

Unfinished composite (flash), which extends onto areas that have not been prepared and properly bonded are prone to early staining and chipping. This tends to be found most commonly around sharp cavosurface margins on functional surfaces.

Fore more detailed information about composite treatment refer to the "Venus User Guide"

iBond in Class III and IV

Preparation

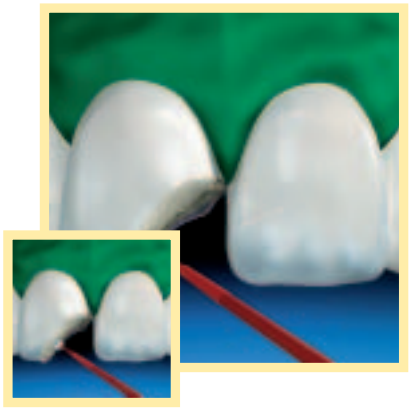
- Prepare the tooth according to accepted principles of the solvent
- Then continue evaporating for a few seconds with a strong jet of air to dry any residual solvent.
- Complete evaporation is indicated by a tough, uniform, homogeneous shiny adhesive film.

Cleaning the cavity

- Before applying iBond, clean the entire prepared surface thoroughly with the water spray.
- Proper isolation techniques (e.g. rubber dam) should be used.

Applying iBond

- Starting first with the enamel (1) apply 3 copious layers of iBond to the prepared enamel margins and slightly beyond, then move to the dentin (2).
- After applying the third layer of iBond allow it to remain in place for 30 seconds. Slight agitation during the waiting time may improve bond strengths.



Evaporation…

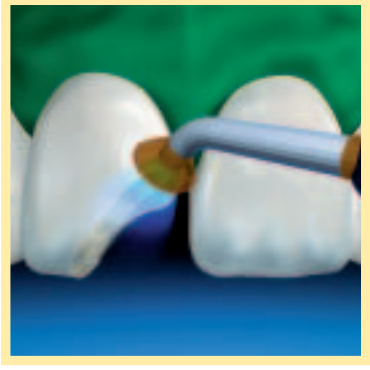
- Dry the iBond thoroughly with a gentle jet of air until there is no undulating movement visible in the adhesive film.

… of the solvent

- Then continue evaporating for a few seconds longer with a strong jet of air to dry any residual solvent.
- Complete evaporation is indicated by a tough, uniform,

Polymerisation

- Polymerise iBond for 20 seconds with a halogen curing light.
- The composite material (e.g. Venus) can then be applied.



iBond in Klasse V

Preparation

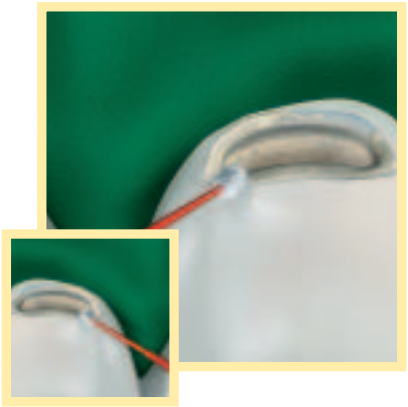
- Prepare the tooth according to accepted principles of minimally invasive technique.
- Prepare the enamel and dentin to the dimensions of the defect.
- Complete evaporation is indicated by a tough, uniform, homogeneous shiny adhesive film.

Polymerisation

- Polymerise iBond for 20 seconds with a halogen curing light.
- The composite material (e.g. Venus) can then be applied.

Applying iBond

- Starting first with the enamel (1) apply 3 copious layers of iBond to the prepared enamel margins and slightly beyond, then move to the dentin (2).
- After applying the third layer of iBond allow it to remain in place for 30 seconds. Slight agitation during the waiting time may improve bond strengths.



Evaporation of the solvent

- Dry the iBond thoroughly with a gentle jet of air until there is no undulating movement visible in the adhesive film.
- Then continue evaporating for a few seconds longer with a strong jet of air to dry any residual solvent.
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Polymerisation

- Polymerise iBond for 20 seconds with a halogen curing light.
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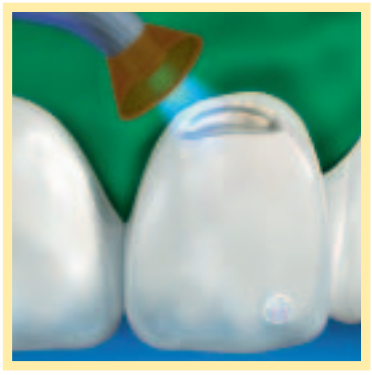

For more detailed information about composite treatment refer to the "Venus Users Guide"

User tips

iBond greatly facilitates routine work in the practice. Certain points should however be noted.

As with any new material, certain steps or stages during application may differ from the previous system used. Though iBond is very easy to use, read the instructions carefully before using it for the first time and adhere strictly to them.

What points should be noted when using iBond?

The following measures ensure consistent quality for the lifetime of the product – from the first to the last drop!

- iBond should be shaken before use. This guarantees even dispersion of all the ingredients in the solution.
- Once opened or dispensed, iBond should used clinically within 3 minutes.
- After dispensing from the iBond bottle, close the cap again immediately to prevent any solvent evaporating.
- iBond should only be used and applied to roughened (prepared) enamel, as its etching ability is not as effective on unprepared enamel layer (due to the presence of the aprismatic layer). If working on unprepared enamel or schlerotic dentin, a separate etching step with phosphoric acid for 30s is needed
- iBond should only be used in combination with light-curing. As with other self-conditioning adhesives, there is inhibition of the setting reaction if a purely self-curing material is used.
- iBond should be stored in a refrigerator (4 – 10°C) outside of practice hours (weekends, holidays). iBond does not have to be stored in the refrigerator between treatments.
- iBond can be a little cloudy when taken from the refrigerator. We recommend allowing iBond to reach room temperature before use.

The cloudiness does not however, impair the bonding function of iBond!

When should iBond no longer be used?

iBond has an integrated safety feature which ensures reliable performance. Any of the following characteristics would indicate that the material is losing its bonding efficacy.

iBond should no longer be used if …

- No liquid can be detected in an iBond single dose or comes out when the iBond bottle is squeezed, even though there may still be some iBond in the bottle.
- Gel-like coagulated particles are visible in the liquid.
- The material has a honey-like consistency or it seems sticky when applied with the microbrush.

Why iBond should not be used in combination with self-curing composites

A recurring question with self-etching adhesives is whether they can be used successfully with light-curing, self-curing or dual-curing materials. Acid components found in the oxygen inhibition layer of the dental adhesive tend to have a significant inhibitory effect on polymerisation mechanism of all self cured composites at their interface with the adhesive.

Therefore, the combination of self-conditioning adhesives with chemically (self) curing composites is therefore contraindicated.

Light-curing composites are not affected by this acidic interface.

A range of packaging options are available for the practice:

iBond Bottle Assortment
4 ml bottle, accessories (application instruction card, application tips, dispensing well)
Order no.: 66008943

iBond Value Pack
3 x 4 ml bottles, accessories
(3 x 50 application tips, application instruction card, dispensing well)
Order no.: 66015847

iBond Single Dose Assortment (40)
40 x 0.2 ml for single application, accessories (application instruction card, application tips, single dose and tip holder)
Order no.: 66008944

iBond Single Dose Assortment (80)
80 x 0.2 ml for single application, accessories (application instruction card, application tips, single dose and tip holder)
Order no.: 66009302

Frequently asked questions and further information can be found on the Internet at:
www.iBond.de

Looking back on the development of dental adhesive materials, there is a clear preference and trend towards reducing the number of application steps and simplified handling. Even though iBond was developed to fulfil these user demands, a reasonable amount of clinical care and judgement is still required to exploit its positive characteristics fully.

In order to use self-conditioning adhesives successfully, it is important to recognise the differences between them and conventional total-etch systems. You should always try to understand each step and its background and strictly follow the manufacturers instructions for use.

It should be noted that much of the information given here not only applies to iBond, but also to other self-conditioning materials on the market. In providing this background information Heraeus Kulzer is putting its philosophy of giving all users informations of the technique and benefits of materials as well as dealing with difficult aspects of the technique into practice. Heraeus Kulzer ultimately has the same aim as its customers: durable, aesthetic restorations for patients.

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