New possibilities in orthodontics with the light-curing Orthocryl LC acrylic, Part 1

The light-curing alternative

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Especially in orthodontics, finding materials for patients sensitive to methyl methacrylate can be challenging. The complicated fabrication of delicate appliances with wire and screw elements makes thermoforming and thermoplastic procedures very costly; quite a few appliances can´t even be fabricated with these procedures. With Orthocryl LC (LightCuring) fabricating complicated appliances such as the function regulator becomes easy and convenient. Dental technician Oliver Handwerk writes about his experiences with this new material.

Acrylics are indispensable materials in dental medicine. They are used in many different ways in both dental clinics and laboratories.

Acrylics are used during almost every phase of a restoration – in the clinic in form of silicones for bite registrations or for customized impression trays, etc. But dental acrylics are also necessary for almost all further processes in the laboratory: when fabricating a model for plastic stumps or as base plates for cutting models or for gingival masks. At a later stage, light-curing acrylics are used during modeling with special waxes, which are mixed with light-curing acrylics, and for fabricating matrixes or duplicating forms and during many other procedures. In laboratory procedures, factors like dimensional accuracy, simple and fast processing, storability and material price are important decision criteria. Acrylics that are only used in laboratories should obviously be non-toxic and easy to dispose of. The technician´s health should not be in danger due to unhealthy vapors or skin contact during processing. Biocompatibility is obviously not the only important criterion for these materials, especially because these lab materials are usually only used during processing and not in the patient´s mouth.

Biocompatibility

However, most acrylics are used to fabricate dental appliances that end up in the patient´s mouth. These include thermoplastic bite plates, night guards, miniplast splints, bleaching trays, tooth-colored veneering, temporary restorations, partial or complete dentures and last but not least orthodontic appliances. The requirements are as varied as the forms of use – but they all have one characteristic in common: they all have to be absolutely biocompatible and well tolerated by our body, even when they are in the mouth for a longer period of time.

According to the Medical Devices Act, dental acrylics that are used in the mouth are medical devices; depending on the period of time the acrylic stays in the mouth, it is either Class I or IIa. Thus, they must comply with the appropriate classification directives. The most commonly used acrylics for dental procedures are polymethyl methacrylates (PMMA). PMMA is commonly known as Plexiglas. For dental appliances – such as the pink prostheses – the PMMA is died, for example with anthraquinone dyes and organic and inorganic pigments. PMMA has proven its worth in dental usage and until now there has been no alternative. However, the material is not completely free of complications. PMMA acrylics are chemoplastic materials; i.e. they consist of a powder liquid combination, which is cured with a radical polymerization reaction. The following chain reaction transforms the monomer liquid (MMA) into polymer (PMMA). Pure MMA liquid shrinks about 20 percent, which would make fabricating a precise appliance practically impossible. In order to prevent this problem, the powder is mixed with pre-polymerized parts and other fillers. This way, shrinkage is reduced to about five to six percent.

Allergens

Another problem is caused by the chemical reaction. To prevent an uncontrolled polymerization of the monomer liquid – triggered by heat or light for example – the liquid contains inhibitors (retarders). This makes the liquid storable for a longer period of time. On the other side the powder contains an initiator (dibenzoyl peroxide = BPO) that triggers the reaction between monomer and polymer after they are mixed. The polymerized PMMA keeps containing partially cured initiator parts and monomer residues between the molecule chains. These are believed to cause allergic reactions and irritations. The percentage of monomer residues is about one to five percent depending on the type of procedure. This percentage mostly stays below the limit value set by the Directive ISO 20795, but is still higher than desired. The BPO parts that do not fully cure and remain in the end product are also believed to trigger allergic reactions and are included in the tests if allergies are suspected. De facto however, BPO is not an allergen, merely a very strong irritant [1]. Since BPO is not water soluble, it can only be removed from the appliance with a two-hour post-polymerization in the drying chamber. The residual content then is close to zero [2]. However, integrating a time-costly procedure such as this in the daily lab workflow is

Fig. 1

Fig. 2

Fig. 1: Biocryl foils are available in different colors and designs

Fig. 2: Fixating the elements to the model in the Biocryl technique

difficult. In addition, the risk of changes in dimension and fit during thermo treatment at 100 °C/ 212° F is relatively high, even if the appliance rests on the model during the procedure.

Alternative acrylics in orthodontics

Nowadays, patients are very sensitive towards material tolerability. The number of confirmed PMMA allergy cases however is relatively small. The relevant literature refers to prevalence rates of less than one percent of the popularity [3,4]. This is also due to the fact that the oral mucosa is less sensitive than commonly thought. Analyses indicate that it takes a ten to twelve times higher concentration of allergens to trigger an allergy in the mouth than to trigger a contact allergy on the skin. Although orthodontic appliances stay in the mouth of children and youths for only hours at a time, orthodontists prefer using biocompatible materials for this age group.

The commonly applied salt-and-pepper technique has proven to be the best procedure in orthodontics to mix cold-curing polymers, since it keeps the residual monomer content as low as possible. Additionally, the grain size specification controls the void volume and therefore the exact monomer quantity necessary to cover the polymer. This leads to a consistent mixing ratio. The doughing technique requires a higher percentage of monomer, which consequently leads to a higher residual monomer content.

PMMA foils

The dental industry has been trying to further reduce or eliminate problems like allergy potential etc. for years now.

To maintain the advantages of PMMA and at the same time prevent the disadvantages, special acrylics have been developed (e.g. an acrylic made of thermoplastic nylon). They are mainly used in prosthetics where they are injected in a form or something similar using thermo injection molding. In orthodontics, these procedures only have limited applicability, since fabricating complex orthodontic appliances with wires and screws using these procedures is hardly manageable in an everyday workflow. Orthodontic appliances often have to be adapted or repaired due to growth or changes in the dentition, which is a problem in appliances that cannot be repaired well. They often require complete rebasing.

Industrially pre-produced PMMA is to a great extend free from monomers thanks to a different processing procedure and therefore does not trigger allergies. A good and workable procedure to process industrially pre-produced PMMA acrylics in orthodontic dentistry is pressure molding with

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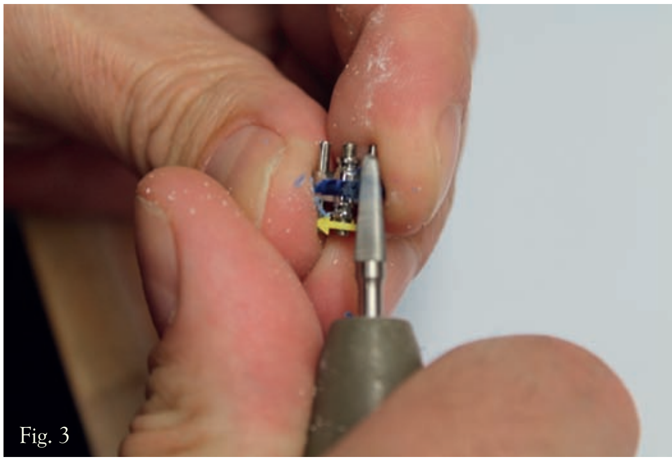

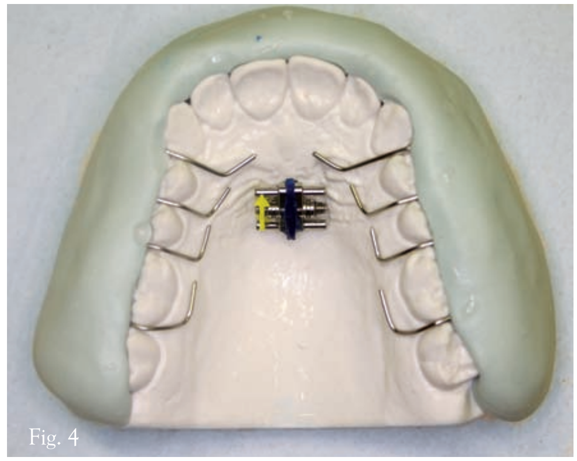

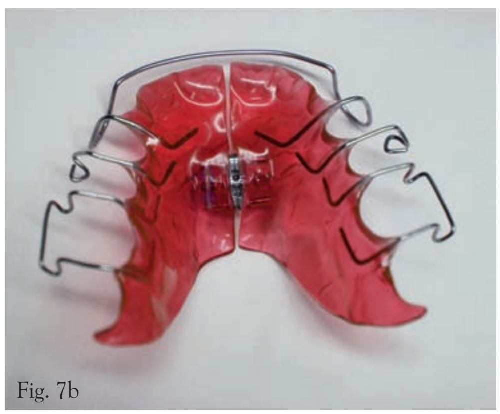

Fig. 3: Cutting the placeholder to prevent it from disturbing during pressure molding

Fig. 4: Fixating the clamps with permanently plastic silicone

Fig. 5: "Relining" screws and clamp retentions with Biocryl acrylic immediately before pressure molding

Fig. 6: Pressure molding the foil onto the soft acrylic

Fig. 7a: Perfect finish and ...

Fig. 7b: ... delicate thickness of Biocryl plate

Biocryl foils made by the company Scheu Dental (Iserlohn, www.scheu-dental.com). The company offers PMMA foils in thicknesses between 1.5 and 3 mm and in different colors and designs (Fig. 1). The first steps of the processing technique are similar to the conventional fabrication of an orthodontic appliance. The wire elements have to be bent and fixed on the model with wax (Fig. 2). Expansion screws can also be added to the appliance, but the placeholder has to be removed prior to pressure molding and be replaced with permanently plastic silicone, since the placeholder would disturb during processing. It is even better to simply cut the placeholder (Fig. 3). It is important to take into account that sticky wax would warm up and loosen itself during pressure molding if it is used to fix the clamps. The vestibular parts should therefore be covered with permanently plastic silicone (Fig. 4) and separating agent should be applied to the model. Since the pressure molding foil cannot completely enclose the retentions and screws from the basal side, the retention parts of the clamps and the screws must be invested with Biocryl cold-curing polymer immediately prior to pressure molding (Fig. 5). The foil is then pressed onto the still soft acrylic mass (Fig. 6). After the foil has cooled down, the acrylic mass and the foil are connected and can be finished as usual. The result is a very delicate appliance with a very homogeneous surface that is very stable and fracture resistant despite its reduced thickness (Fig. 7a and 7b). Adding complex sector screws in this technique is very complicated and requires using a significant amount of cold-curing polymer to integrate the screws, which would limit the advantages of pre-produced PMMA foils. That is why this procedure is mostly used for simple expansion or retention plates.

PMMA alternatives

A completely PMMA free alternative is the LAMItec technique (Hinz-Dental, Herne, Germany). This technique involves two foils made of polycarbonate (PC) and soft polyurethane (PU) (Fig. 8). The system

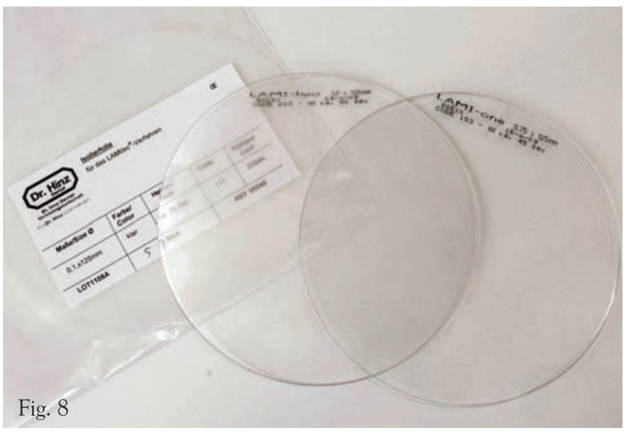
Fig. 8

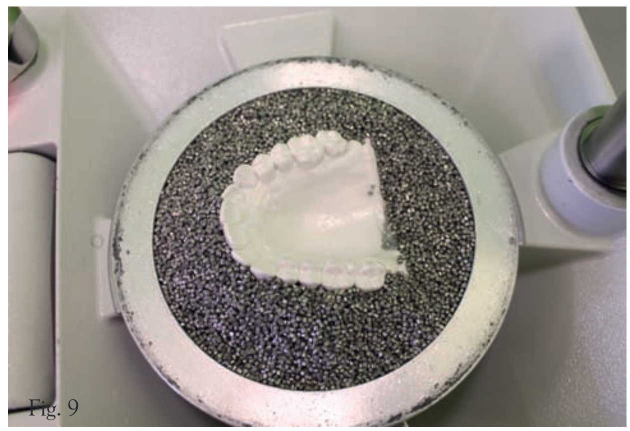
Fig. 9


Fig. 10

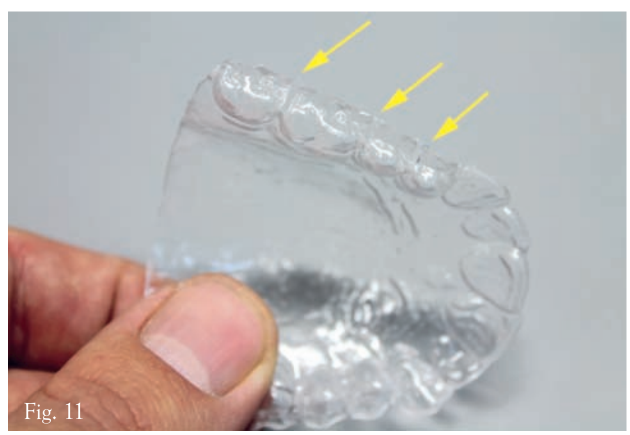
Fig. 11

Fig. 8: The LAMItec foils

Fig. 9: Inserting the model deep into the granulate

Fig. 10: Shorting the LAMIone to the fissure center and smoothing edges

Fig. 11: Milled grooves for the wire retentions

Fig. 12

FIg. 12: The clamps rest directly on LAMIone

Fig. 13: Fixating the screw in a drilled hole

Fig. 14: Fixating the clamps with permanently plastic silicone

Fig. 15: Enclosing the screw with cold-curing polymer ...

Fig. 16: ... and curing

Fig. 13

Fig. 14

Fig. 15

Fig. 16

is based on a hard-soft-hard bond between two foils: the process starts with pressure molding the first foil (LAMIone, 0.75 mm PU) onto the model. The model should be deeply inserted into granulate, since it is not necessary to invest the vestibular parts of the model (Fig. 9). Then, the foil has to be shortened to the center of the tooth fissures with a bone cutter or something similar and the edges have to be smoothed (Fig. 10). In the approximal areas, small grooves should be added for the attachments, otherwise the wires will later rest clear of the acrylic (Fig. 11). Next, the wires have to be bent and together with the screws be placed on the model. The retentions must rest on the LAMIone foil without a gap (Fig. 12). For a secure hold, the pin of the placeholder has to be inserted in a hole in the model (Fig. 13). The screw opening has to be sealed with silicone or the placeholder can be cut directly above the screw body, since it would disturb during pressure molding. Just like with Biocryl, the wire elements have to be fixed with permanently plastic silicone (Fig. 14). To completely enclose the screw

Fig. 17

Fig. 18

Fig. 17: Pressing LAMItwo with the soft side onto the model L11

Fig. 18: Easy removing from the model, the clamps are fixed tight

spindle, some cold-curing polymer has to be added around the screw (Fig. 15) and be polymerized in the pressure pot (Fig. 16). The model has to be blow-dried so that the LAMIone foil can be processed with the LAMIbond bonding agent. Next, the second foil (LAMItwo; 1.8 mm PC/PU) has to be pressed tightly (Fig. 17) onto the first foil so that they are fused together. The attachments between the two foils are now held tightly between the two layers. The laminated appliance base can now be removed from the model (Fig. 18) and finished as usual (Fig. 19). It is recommended to use a special milling instrument for permanently plastic acrylics. You can use a pumice stone for polishing. The result

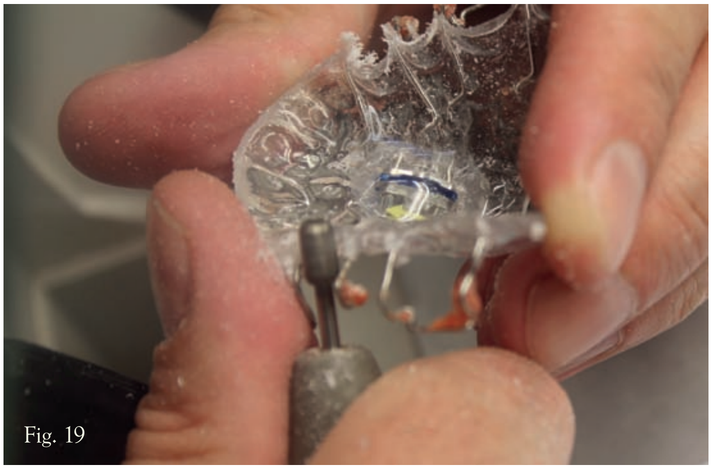

Fig. 19

Fig. 20

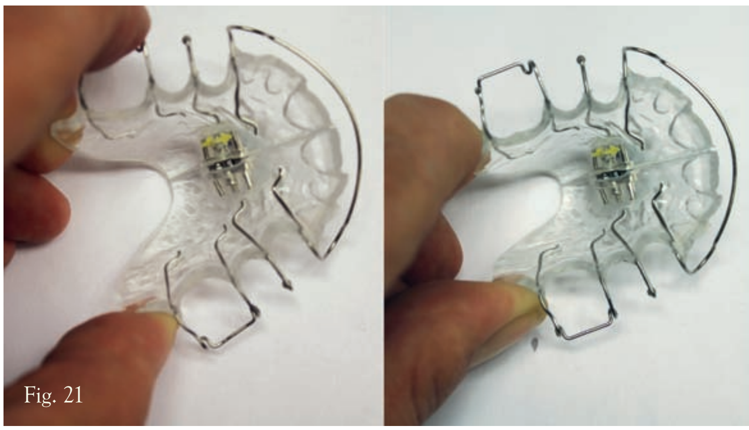

Fig. 21

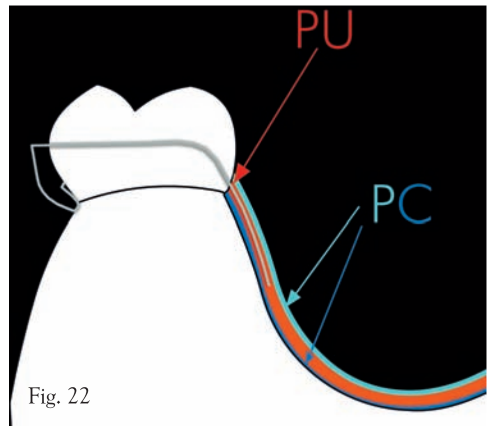

Fig. 22

Fig. 19: Finishing with special milling instruments

Fig. 20: Brilliant surface and crystal clear acrylic body

Fig. 21: The LAMItec plate is very flexible

Fig. 22: The inner layer could discolor at the interface hard-soft-hard

is a delicate and crystal clear plate (Fig. 20) that is extremely flexible and fracture resistant (Fig. 21). The main problem with this procedure is once again that the material is difficult to repair. The polycarbonate layer connects with the acrylate but not with the PU. Adaptations or a simple clamp fracture often require rebasing. There also remains a slim rim mostly on the basal side. In this area, the PU parts are exposed. These permanently plastic parts tend to discolor over time to yellowish-brown (Fig. 22). Eliminating this discoloration is difficult if not impossible and often leads to complaints. In conclusion, the existing alternatives to the conventional salt-and-pepper technique are well thought out and well suited for certain indications such as retention appliances. However, using these alternatives to fabricate more elaborate devices or functional orthodontic appliances such as the function regulator is very costly if not impossible.

Dentaurum in Ispringen, Germany is striking a new path and has developed a completely new acrylic based on the well-known Orthocryl acrylic: Orthocryl LC (LightCuring) – read more about it in Part 2 of this article in the next issue. Sd

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