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
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 acrylcs 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 acrylcs 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.

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

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

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 acrylcs in orthodontic dentistry is pressure molding with
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
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 retainments 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: 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

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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.

Sources:
Dentaurum in Ispringen, Germany, has developed a completely new acrylic based on the well-known Orthocryl acrylic: Orthocryl LC (LightCuring). The aim was to provide an acrylic that can be used for all types of orthodontic appliances without any restrictions.

The use of light-curing acrylics in prosthetics is not that new; however, essentially tray material or veneering acrylics made of light-curing acrylics have been available so far. Viscoplastic rods for bite splints (e.g. Primosplint from Primotec, Bad Homburg) have been available for some time. However, these viscous rods with a diameter of approx. one centimeter are not suitable for the fabrication of orthodontic devices. The advantage of light-curing acrylics is the higher polymerization degree. Only a lower monomer content remains in the polymerized product, which results in a much better biocompatibility and higher density of the material and thus also in a high level of stability. Dentaurum presented the outcome of these developments in 2014: Orthocryl LC (LightCuring). The light-curing acrylic is available in six colors (red, blue yellow, pink, green, transparent) and delivered ready-to-use in opaque cartridges. The black cartridges contain only one component and are intended for storage and application (Fig. 23); i.e. it is no longer necessary to mix the material.

Orthocryl LC meets all the requirements that an orthodontic acrylic must fulfill:

- No restrictions regarding the application: active plates, orthodontic devices, but also splints etc. can be fabricated with Orthocryl LC
- Good reparability
- Easy Integration of complex elements such as screws, etc.
- Easy processing, quite similar to salt-and-pepperin
- Available in different colors
- Good storability
- Suitable for people with allergies, since it does not contain allergenic substances such as MMA or BPO
- No restriction, since it is neither a dangerous substance nor a dangerous good
- No hazard to the technician’s health from monomer vapors

The acrylic has an outstanding visual appearance: it is odorless, crystal clear and absolutely homogeneous. The colors are pleasant, but moderate to keep the dye proportion as low as possible and to ensure a uniform curing of all colors in the light-curing unit.

**Application**

The application is quite easy. As in the “salt-and-pepper” technique, wires, screws and other elements can be added to the model; special measures are not required (Fig. 24). Recommendation of the author: especially the screws and other oral
Fig. 23: The Orthocryl LC acrylics are available in six colors.

Fig. 24: A separate preparation of the models is not necessary.

Fig. 25: When applying the material, the screw can be slightly detached from the application tip.

Figs. 26a-c: Fixating the screw in a drilled hole.
elements should be firmly fixated, because the application tip may come into contact with the placeholder of the screw while applying the material (Fig. 25). The screws from Dentaurum are provided with an extension for the placeholder, which will be countersunk in the model (Fig. 26). It is NOT necessary to soak the model; just apply a separating medium for plaster or acrylic (e.g. separating medium REF 162-800-00, Dentaurum) (Fig. 27). The acrylic is applied using a special dispensing gun (Fig. 28) and a small nozzle.

However, it does not have any mixing function but only facilitates the application on the model. The thin strand coming from the cartridge flows easily on the model and becomes a fairly homogeneous surface. Nevertheless, the stability is optimal; the acrylic does not flow to the deepest point but stays at the chosen spot. The thin tip makes it easier to enclose the screws and the springs without bubbles. This must be done first (Fig. 29). Only afterwards can the base be coated (Fig. 30).

The manufacturer recommends
extracting the screw from the wax for perfect enclosure, applying the acrylic and then reinserting the screw. However, it was not necessary to proceed this way in our laboratory, for the screws were easily enclosed by the acrylic. A bit unusual is the fact that a quite long “tool” is formed by combining the dispensing gun, the cartridge and the tip (Fig. 31). Exact guidance of the tip during application requires a bit of practice. Also unusual is the fact that the applied acrylic can hardly be preformed or reduced with instruments prior to curing, since it remains soft during the whole operation. The surface too, unlike with the “salt and pepper” technique, cannot be condensed through “smooth scattering” or tapping or shaking.

A plus: the acrylic is so clear that one can make a visual control of the layer thickness during the whole procedure. Potential air bubbles can be clearly identified and easily removed from the acrylic with an instrument (Fig. 32). The layer thickness should not be too thin, as the curing process produces a thin inhibition layer on the surface that has to be removed with a cleaning agent made of ethanol (Fig. 33). The curing process takes place in a commercial light-curing unit (Fig. 34) - it should have a performance of 4 x 150 Watt (600 W) and a wave length of 400 to 550 nm. The
Fig. 33: A cleaning agent made of ethanol for removing the inhibition layer

Fig. 34: Primary curing process takes 6 minutes

Fig. 35: The appliance can be easily removed

Fig. 36: Removing the inhibition layer

Fig. 37: For finishing, use hard metal burs or burs for soft acrylics

Fig. 38: Machining produces a fine-grained, soft dust
primary curing time is six minutes. After that the base can be easily removed (Fig. 35). The appliance is then polymerized for three minutes without model from the basal side.

Afterwards the oxygen inhibition layer that appeared in form of a dull, slightly sticky smear layer is removed. This is achieved by wiping it with an ethanol-impregnated fabric.

Finishing is performed as usual. The manufacturer recommends hard metal burs with transversal toothing or burs for soft acrylics. During the test period, we used hard metal burs with transversal toothing, which have led to equally good results. The acrylic produces a very fine-grained dust during finishing, which recalls the tray material (Fig. 38). Fine surface finishing is performed as usual with sand paper or pumice powder. The result: a homogeneous plate base with a pleasant color (Fig. 39) and smooth surface. The model details are superbly reproduced on the bottom of the base; this is also reflected in the very good fit.

The use with functional orthodontic appliances - easy and problem-free with special bite paste. The fabrication of orthodontic devices with alternative acrylics is too laborious to work successfully with the existing thermoforming procedures. With Orthocryl LC however, the fabrication of a base is even easier than with the “salt and pepper” technique.

To facilitate the application in the interocclusal layer, the manufacturer offers a special bite paste. This is significantly more viscous and stable than the standard material. As the paste is too viscous for the cartridge gun, it is supplied in a small opaque glass jar (Fig. 40). To fabricate an activator, the models are prepared as usual and plastered in a fixator. The wire elements are bent and waxed as usual (Fig. 41). There too, no soaking is necessary; separating is performed with alginate separating medium. At first, the standard material is applied on the two quadrants (Fig 42a and 42b). The application of the bite paste comes next. The best in this case is to use a small spatula. At first, the occlusal surfaces are thinly but entirely coated (Fig. 43). One should try to fill the occlusal surfaces as well as possible. The bite plane is then fitted (Fig. 44). It is recommended to
apply a layer that is approx. 3 mm thicker than actually needed on the bite plate, so that when the fixator parts are joined together some pressure is created on the acrylic paste, making it possible to compress it bubble and gap-free.

During the curing process, first cure for approx. six minutes, as with plate appliances. When positioning in the curing unit, make sure that sufficient light comes through the oral area (Fig. 45). After completion of the first curing process, the device is removed and cured for another six minutes without models (Fig. 46). Finishing is performed once the inhibition layer has been removed with the recommended abrasives. Polishing can be significantly facilitated if the
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oral parts of the acrylic base are additionally smoothed with a silicone polisher (Dentaurum) (Fig. 47). In our laboratory, we use a pumice polishing paste (Art. 5200160, bredent, Senden, Germany) to polish devices that cannot be finished optimally at the polishing lathe and a canvas buff for the handpiece (Fig. 48). After polishing (Fig. 49), one can clearly see how excellent the fit is despite the viscous texture of the paste (Fig 50). Due to the similarity with the “salt and pepper” technique, the fabrication of complex appliances such as function regulators etc. is not much more elaborate with Orthocryl LC than with the “salt and pepper” or the doughing technique.

Summary

Orthocryl LC is an excellent alternative to conventional PMMA acrylics in orthodontics. There is no appliance that cannot be fabricated with Orthocryl LC because of the manufacturing method. Apart from fabricating all orthodontic devices, we also routinely produce adjustable bite plates (Michigan, yellow plates, etc.) in our laboratory with Orthocryl LC.

Even the repair of appliances made out of Orthocryl LC has so far been unproblematic. The reparability is good. However, roughening a large surface around the fracture/repair point to ensure a good bond between the repair piece and the material has proven effective. We always use Orthocryl LC in our laboratory when there are known allergies to PMMA. Even patients who have tested
positive for PMMA can be treated with Orthocryl LC. Light-curing acrylics are certainly no general substitutes for the conventional “salt and pepper” technique, as material costs alone are higher than those of conventional cold-curing polymers. But also the application itself requires a bit more time. However, Orthocryl LC is a perfect substitute for sensitive patients and for those with allergies. It is perfect for orthodontic applications, since it does not considerably complicate the fabrication process but ensure reliable and predictable results. Orthocryl LC is free from methyl methacrylate, dibenzoyl peroxide and bisphenol.