MONOMER-FREE ACRYLIC WITH EXTREMELY LOW SHRINKAGE

# The low-allergen denture

Plastics play a key role in dentistry today as the raw material in cements applied in restorative dentistry, the base material for dentures and in other applications. Polymethyl methacrylate (PMMA) has been the standard for this prosthetic application as far back as the 1950s. **by Jip Kreijns**

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AT THAT TIME, PMMA came to replace vulcanised rubber dentures, which were often difficult to manufacture. The switch from rubber to plastic happened relatively smoothly due to the superior qualities of a PMMA compared to a rubber denture.

In spite of very rapid developments in the field of plastics, after more than 60 years the majority of dentures are still produced from materials based on the two-component system, consisting of methyl methacrylate MMA and PMMA. In the meantime, many variants of these materials have been developed and processing techniques are getting faster all the time. In contrast to the last century when all pieces were still being pressed, moulding is now the standard. Why then is there a need for new materials and/or techniques for the manufacture of dentures?

## Allergy

Due to the continuous and more extensive use of foreign materials and the development of new dental materials, the number of cases of allergic reaction also appears to be increasing. Well-known allergens include residual monomer, peroxides and metals, however the number of undesired reactions to denture base materials is also increasing. This is to be explained in part by the additives used.

The plastics used to manufacture dentures often consist not only of PMMA, but also of other added plastics and colouring agents. The leaching of colouring agents or denture cleansing liquids, and the release of residual monomer can cause allergic symptoms. This risk is highest immediately after a new denture has been fitted or following repair. The production technique plays a vital role in the amount of residual monomer released. Cold polymerisates (mostly applied for repairs and rebasings) lose more residual monomer in the initial stages than hot polymerisates. The latter are primarily used for new dentures. ▶

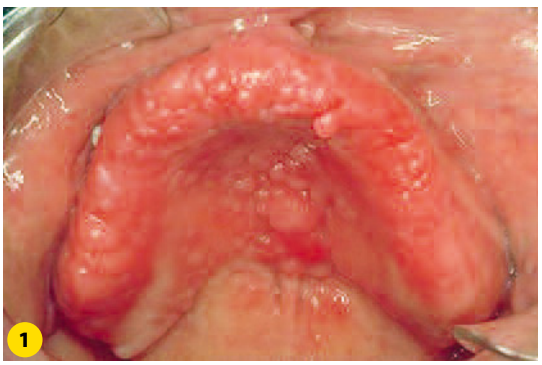



**Fig. 1** An allergic reaction to polymethyl methacrylate makes wearing an upper denture virtually impossible.
**Fig. 2** Working with monomer can cause a severe allergic reaction, resulting in unfitness for work.

**Fig. 3** Broken dentures are usually repaired with cold-polymerising resin. These cold polymerisates lose a relatively large amount of residual monomer in the initial stages.
**Fig. 4** Colouring agents are added to the PMMA denture.

## Burning

One frequently occurring symptom reported by denture wearers, which is similar to an allergic reaction, is that of a burning sensation in the mouth or on the tongue. These symptoms, similar to those of *burning mouth syndrome (BMS)*, can make the wearing of a denture virtually impossible. It is estimated that around 1 to 5 percent of adults suffer from a painful or burning sensation of the oral mucosa. A key characteristic of BMS is that no underlying dental or medical cause of the symptoms can be demonstrated. During the day, the pain may vary in severity and can last for many years. This is a very common clinical complaint, in which anomalies are not usually observed in the mucosa. Around 70% of BMS patients suffer from taste disorders, also known as *dysgeusia*. Patients generally complain of a bitter or metallic taste (or both) in the mouth.

Most of the patients indicate that the symptoms of burning mouth syndrome have a huge impact on the quality of their lives. The cause is often related to bio-incompatible reactions to materials which can leak out of the denture and induce a local toxic or allergic reaction. Patients who are shown to have an allergic reaction following a proper dermatological examination will benefit from avoiding the allergen. These reasons alone give good grounds for seeking alternatives to methyl methacrylates as a base material for dentures as well as investigating other processing techniques for this plastic.

## Absence of hazardous materials

Many other production techniques have been developed over the past 40 years in addition to pressing and/or moulding dentures from a MMA-PMMA system: from light curing paste systems to microwave polymerisation, and from the closed injection technique to thermoplastic systems. The latter techniques in particular offer a range of variants and options which however are not in common use. The flexible character and often poor appearance of the materials is one of the main reasons why these thermoplastic techniques have not gained any real popularity in Europe. As a result, development of the material and associated techniques has not proceeded, preventing any real breakthroughs for thermoplastics.

Nevertheless, there are many reasons why thermoplastic products are ideally suited to the world of dental mechanics. In the first place, these products are completely free of residual monomers, accelerator systems and stabilisers. Secondly, thermoplastic products are always homogenous in composition and thirdly they respond consistently during processing. Last, but not least, is the fact that thermoplastic materials have no adverse impact on the technician or the dental lab due to the absence of hazardous materials.

## Types of thermoplastics

Thermoplastics are polymers which can be made reversibly liquid by raising the temperature. They are placed in a mould when in a molten state and later fixed after the mould has cooled down. A range of thermoplastic materials are used in dental mechanics. Alongside polymethyl methacrylates, which can also be effectively processed thermoplastically, nylons are the best known of these. The chemical name for these materials is polyamides, often abbreviated to PA.

Also used, although less familiar, are acetal and polystyrene. Acetal is a polyoxymethylene or POM. Polystyrene is abbreviated to SAN since the full chemical name is styrene acrylonitrile. Their physical properties and diversity make each of these materials unique in terms of processing and application.

Thermoplastics based on POMs are characterised by high breaking strength, wear resistance and flexibility. However, these thermoplastics lack the natural translucency typical in PMMA. Polycarbonates, on the other hand, are translucent and have sufficient flexibility and breaking strength, but are very susceptible to wear and tear. For this reason, polycarbonates are suitable for temporary work but not for permanent dentures. PMMA, as a thermoplastic material, appears to be the ideal product, but the high processing temperature and viscosity mean it is not easy to process.

## Polishing

The most commonly used thermoplastic materials are based on PA. These polyamides are primarily characterised by their flexibility, toughness, high breaking strength, ▶

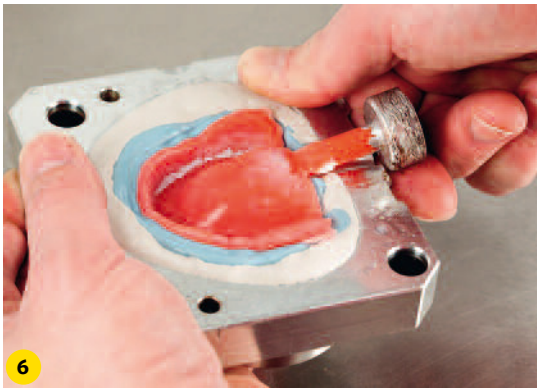

**Fig. 5** Polishing ThermoSens dentures is relatively straightforward. **Fig. 6** Polyamide can also be used for bridges.

transparency and resistance to heat and chemical effects. These characteristics mean polyamides have up to now primarily been used in countries, such as America, Asia and Eastern Europe, as an alternative to expensive frame dentures. The division in these markets is striking: on the one hand there is the private sector where relatively expensive PMMA dentures are made and on the other hand the public sector in which relatively cheap PA dentures are manufactured. In the public sector the quality standards are not as high and less weight is given to the 'outward' characteristics of the denture. Moreover, the low wages of dental technicians mean the longer time taken for finishing work does not significantly impact on financial costs. Polishing in particular is relatively time-intensive as producing the shiny appearance on "plain" PA materials involves a considerable amount of work.

## New material

Due to the demand for a low-allergen denture material and the drawbacks of existing thermoplastics, Vertex-Dental BV identified a need to develop a new thermoplastic material and associated processing techniques. As a result, the Dutch manufacturer of denture materials set about the business of looking for a low-allergen denture material that could be reliably processed. One of the key criteria was acceptance of the new material among the dental establishment. Due to the physical characteristics and options offered by polyamides, a PA material was finally chosen.

## Physical characteristics

Polyamides differ from other thermoplastics in that they have a very short melting range of just a few degrees, which has a very beneficial effect in relation to the thermoplastic properties of the material. The excellent flow properties of molten polyamide make the material suitable for refined workpieces with a high degree of reproducibility.

Polyamides have a number of mechanical and physical properties that permit the production of very thin workpieces with no concomitant reduction in quality. These properties include high mechanical strength, a high level of stiffness (read: elasticity), and excellent wear and impact resistance. Toughness is also maintained at both high and low temperature and polyamides are resistant to fatigue symptoms. Their semi-crystalline composition gives them strong chemical resistance.

The degree of crystallinity ensures the material remains in a fixed state at high temperatures up to the melting point of over 240 °C. This results in good shape retention in the mouth.

## Higher material density

This new material called *ThermoSens* has been improved relative to standard polyamide materials in terms of its properties. The flexibility of this material can be controlled and shrinkage is extremely low.

In terms of composition, a homogenous colour is achieved and as a result this new thermoplastic material is also suitable for full dentures. The processing techniques have been transformed to the extent that there is virtually no need for polishing and any polishing that does take place is relatively straightforward.

The injection technique using the ThermoJect in combination with cannulas allows for automation of several processing steps. Pre-installed programmes, which eliminate weighing or mixing problems, and a clear protocol minimise the risk of error. Moreover, the injection technique provides for higher material density, resulting in better surface quality.

Finding a solution for patients who are sensitive or have an allergic reaction to residual monomer, accelerator systems or PMMA is an issue increasingly faced by dentists and dental technicians. These problems may manifest themselves among wearers of both partial and full dentures, for which dentures based on polyamides represent an excellent alternative. Vertex Thermo-Sens is a real treatment option for the Dutch market. ◀

*With thanks to Connie Peterse-Van der Koppel. Connie is Director of Operations at Vertex-Dental BV and in this position holds responsibility for the R&D department. She is an organic chemist specialising in polymers.*