

Press Release

## 2nd Heraeus Dental Symposium

### With the aid of science

Hanau, August 14 2008 - **About 90 experts from Germany and elsewhere in Europe visited the second Heraeus Dental Symposium in Frankfurt am Main on 13th June 2008 to exchange ideas on the topic of “Restore with the Appliance of Science“. There were lively discussions about questions on “correct filling therapy“ and treatment reality. The subjects of amalgam along with the potential developments for filling materials and possible alternatives for the future were also included.**

In his opening talk on “Restorative dentistry – materials, trends and wishes“, Prof. Reinhard Hickel, a consultant from Munich University (Germany) and chairman of the symposium, gave an initial overview of the topic. The preferences of practising dentists and universities throughout Europe with regard to the use of dental filling materials diverge greatly nowadays. Whereas in the past cavities were largely still filled with amalgam, dentists from the USA, UK and Germany now mainly use composite materials. The picture is completely different at European universities: in particular, the Czech Republic, UK, Poland and Turkey today still prefer the use of amalgam in the education of students.

### Modern composites are gaining ground

If the broad range of dental filling materials is compared, similar advantages and disadvantages are found in all areas; for instance, amalgam, porcelain and modern composites have quite similar survival rates but also have comparable problems. In the case of composites, these include proximal filling fractures, especially in the

posterior region, due to poor occlusion contacts, material fatigue, shrinkage stress or inadequate light curing. However, after comparing numerous published studies, Prof. Hickel came to the conclusion that where secondary caries is concerned, the modern composite fillings no longer have worse results compared with amalgam fillings. Hickel regards as political the statements in published articles that composite has a shorter survival rate than amalgam. This has not been proven scientifically.

The use of tooth-coloured filling materials with the corresponding adhesive systems has undergone a fundamental change in the past twenty years. There has been a marked increase in the proportion of these materials in European dental practices in recent years. The so-called (nano-) hybrid composites come off best with their ingenious mixture of particles of very different sizes and their controlled shrinkage process. Their particular advantages, according to Hickel, are their better polishability, long-lasting high lustre, excellent aesthetics due to their colour and opacity, lower shrinkage and good physical properties, for example high bending and breaking strength.

In his talk, Hickel also went into the advantages and disadvantages of direct (composite) and indirect restorations. Decisions must be made on a case by case basis when removing caries, replacing old fillings or carrying out aesthetic restorations. The size of the cavity, the individual caries risk, the patient's aesthetic demands and financial options are of particular importance. Composite restorations spare tooth substance through the minimally invasive procedure, are easier to correct, do not have visible margins and are usually more economical. On the other hand, indirect restorations last longer, are suitable for bigger defects and guarantee long-lasting aesthetic results.

Hickel explained what science and practice would like from the industry in future as regards composite materials: excellent material properties, lower fatigue, greater resistance to abrasion, less shrinkage, better adaptability and durability. In addition, biological properties such as biocompatibility, lower postoperative hypersensitivity and protection against secondary caries are of the utmost importance. The materials must meet aesthetic demands as regards shades, stable high-lustre, polishability and stability of form. Where the handling properties are concerned, the "right composite" should also be suitable for large cavities, require shorter light curing, have better flow characteristics, adhere less to the modelling instruments and offer better potential for correction.

## **Dental treatment in Europe**

In the second block of talks, the speakers, Prof. Claus-Peter Ernst (Mainz, Germany), Prof. Antonio Cerutti (Brescia, Italy), Prof. Pierre Colon (Paris, France), Prof. Timothy F. Watson (London, UK) and Prof. Ulla Pallesen (Copenhagen, Denmark), showed that in Europe, there are fundamental differences in tuition in the universities and also the type of financing of the national health systems and sometimes also in the type of treatment.

## **Germany**

Prof. Claus-Peter Ernst of Mainz University presented the special situation of practising dentists in Germany. In 2006 about half of their income came from national health insurance and the other half from private services although about 85% of Germans have national health insurance.

On average, a dentist in German works about 48 hours per week. However, pure dental work accounts for only 35 hours. To meet all

the costs that arise in a dental practice and to achieve an average income of 103,185 Euro, a dentist would have to earn at least 185 Euro per hour on average. Other estimates assumed about 203 or 194 Euro. This would give a price per minute between 3.24 and 3.38 Euro. Using the example of a 2-layer composite restoration, Ernst showed that placing the filling must take only about 16 minutes in a national health insurance patient and approx. 23 minutes in a private patient.

In the private health insurance companies, costs are driven mainly by restorative treatments, which account for 44%. However, the fee for private services, which is calculated according to the fee schedule for dentists (GOZ), has remained constant since 1988. Ernst said that this will change in the coming year when the new fee schedule comes into force.

Apart from staff and laboratory costs, the costs of dental materials constitute the biggest cost sector in an average dental practice. The need for corresponding materials depends on the level of reimbursement by the health insurance funds. Certainly, patients today make greater demands for aesthetics and quality – but the question remains as to whether that will still be payable in future. Amalgam is ultimately much cheaper compared to aesthetic filling materials, according to Ernst. The German dentist today makes his decisions on appropriate treatment 50% from the medical aspect but 50% from financial aspects. This means that he will offer a highly aesthetic solution only if it is correspondingly reimbursed.

## **Italy**

At the 32 Italian universities, restorative dentistry is still limping a bit behind, lamented Prof. Antonio Cerutti (Brescia, Italy). Handling amalgam and composite is taught. However, the predominant need

today is for composite materials since more and more patients want aesthetic restorations. In Italy patients are insured predominantly privately and pay about 200 Euro per year for dental treatment. Amalgam is out of the question for the majority of patients: "They have to pay for the fillings out of their own pocket and they will do that only for "white" fillings", said Cerutti in his talk on the situation in Italy.

Group practices are still rather rare in Italy. Of the approximately 52,000 practising dentists (2006), most have their own practice. As regards materials, Cerutti summarized the wishes of Italian dentists for the dental industry thus: "We not only require new materials but we also want to know how we can better employ them".

## **France**

In his talk, Prof. Pierre Colon (Paris, France) asked whether French universities offer adequate education in the area of restorative dentistry. He first went back to the year 1801, when the first medical "internats" were founded in France. In this special form of higher education, the students are educated to a very high level. Teaching includes both theoretical knowledge and comprehensive clinical training. The dental "internat" has only been in existence since 1994. After a five-year course of preclinical and clinical studies, the students have to have worked fulltime for a period in a dental hospital or dentist's practice before they qualify and obtain registration as a dentist. The universities and internats attach particular importance to students not only dealing with complex cases but also being able to identify interdisciplinary connections. They are also trained to be guided by results: they must document evidence of treatment decisions and the concrete benefits of these decisions for the patient.

## England

Prof. Timothy F. Watson (London, UK) gave a brief overview of the current state of dental care in England and the resulting requirement for dental materials in the universities and in practice. He too went back at the start of his presentation to 1948 when the National Health Service (NHS) was set up. This enabled every patient to obtain free health care at that time. Since the 1970s, the personal share of the costs has risen dramatically. For this reason, amalgam was standard in the UK for a long period. The NHS did not pay for anything else. Up to the 1980s, fabrication of crowns even required extra authorisation so adhesive filling techniques were not even taught in many universities. It has only been in recent years that a new trend has become apparent: "The NHS now allows "plastic fillings" and nearly all the universities want to teach this technique now", according to Prof. Watson.

With the health reform that has been in force since 2006, local Primary Care Trusts (PCT) conclude contracts for the NHS with individual dentists to whom patients from the corresponding region are referred. This results in an entirely new situation for the dentist; he now has to ensure that he keeps exactly within the budget agreed with the PCT. All NHS treatments are divided into three fee categories. For example, a dentist gets three points for a filling. Three points currently correspond to about 66 pounds sterling. If the dentist provides a patient with several fillings at the same time, he still gets only three points. Consequently, patients only get the absolutely necessary treatment. The dentist can no longer cover his costs when treating patients who require a lot of treatment and these are therefore readily referred to dental hospitals. Fortunately, however, they can also decide on private treatment. In this case, the British dentist can decide freely what filling material to use. Prof.

Watson also came to the conclusion at the end of his talk that “ultimately, what always matters is who pays what”.

## **Scandinavia**

In her talk, Prof. Ulla Pallesen (Copenhagen, Denmark), shone the light on the Scandinavian countries of Finland, Norway, Sweden and Denmark. Here patients receive free dental treatment up to the age of 17 or 20 years. Above that age they must have state or private health insurance. Sweden spends the most money on dental treatments.

On the subject of amalgam as filling material, opinions diverge widely not only in Europe but also in Scandinavia. Finland was the first country to start changing from amalgam to tooth-coloured composites. In Norway, amalgam is even prohibited since this year and Sweden wants to follow suit. In Denmark, on the other hand, dentists and scientists have spoken out against a complete amalgam ban for clinical and sociodemographic reasons.

## **The perils of restorative dental materials**

Prof. Albert Feilzer (ACTA Amsterdam, The Netherlands) dealt with the “perils“ of restorative dental materials, their biocompatibility and the potential for development of plastic-based filling materials. There are allergies to nearly all materials used by the dentist – amalgam, gold, nickel (in wires) and plastics. “Even money can make you sick“, laughed Prof. Feilzer and as an example, he showed a Euro coin, which is composed of copper and nickel and can cause allergies on contact with human sweat. In the case of plastics, the allergy problem arises mainly in the dentist and practice staff from the plastic matrix.

Good processing, and this includes adequate curing, reduces residual monomers. This is where the next problems start: on polymerisation, shrinkage stress develops, which can lead to enamel cracks in the filled tooth. Small fillings can produce more stress than large ones (C factor) so minimally invasive preparations lead to more shrinkage stress than amalgam-like preparations. However, in the case of deep cavities, the light intensity of the curing lamps is often insufficient to securely cure the lower increments all through, according to Prof. Feilzer. He therefore recommended introducing layers a maximum of one millimetre thick in deep cavities in order to achieve through-curing. Material fatigue (filling fracture) is a further important topic with composites.

### **There is no material “for all cases“**

The premise that there is “one material for all cases“ always leads to unsatisfying compromises. Indirect composite restorations (crowns, partial crowns) can also be fabricated successfully today with suitable materials, and single-wing Maryland bridges of fibre-reinforced composites are a good treatment option. To be able to develop perfect restorations, improvements must be sought in all three points: indication, biocompatibility and physical parameters.

In the subsequent discussion, Prof. Feilzer like Prof. Gottfried Schmalz (Regensburg, Germany) took up the cudgels for new, improved glass ionomer cements. There is still potential for development here, according to Prof. Schmalz. However, this depends greatly on the money available for research and development.

Can all the requirements made by science and practice actually be met by a single restoration material? Prof. David Watts of the University of Manchester (UK), a materials scientist, posed this

question in his talk on alternative composite materials of the future. He described the search for the “right“ material as a balancing act. A practical biomimetic filling material that imitates natural dentine and can no longer be distinguished from this, which is durable, does not shrink, does not require any adhesive systems, is suitable for all indications and is not sensitive to technique will not be available for dental treatment in the short or medium term, stressed Prof. Watts.

### **Seeing beyond the end of our noses**

In his talk, Prof. Watts drew attention to the natural tooth. In it, hydroxyapatite particles are embedded in an organic matrix. Can something like that be “copied“? Internationally, intensive research on this subject is already underway. A first material, proposed by Heraeus Kulzer and in use in a clinical study at the university of Giessen (Germany) for four months with very promising results contains two source materials for hydroxyapatite – dicalcium - phosphate anhydride ( $\text{CaHPO}_4$ ) and tetracalcium phosphate ( $\text{Ca}_4(\text{PO}_4)_2\text{O}$ ) in an acid base – mixed to a paste with an aqueous solution of organic and inorganic salts. This paste is packable and self-curing and 95 per cent of it is converted to hydroxyapatite after curing. All of the fillings are still in situ with good margin adaptation and visible remineralisation of the natural tooth. However, the homogeneity of the material and the abrasion resistance have yet to be improved. Nevertheless, “tooth repair“ of previously carious lesions in dental enamel with artificial enamel is also conceivable, as presented by Yamagishi et al. in 2005 in Nature.

As regards possible new basic materials for tooth-coloured filling materials, Prof. Watts strongly recommended looking beyond dentistry to other areas of chemistry and the technical application of plastic materials, especially in the two classes of materials with organic and inorganic constituents.

In the subsequent discussion, Prof. Michael Noack of the University of Cologne (Germany) asked the provocative question of whether the dental world does not sometimes place obstacles in the way where aesthetics are concerned. The widespread condition of caries affects financially worse off patients in particular, who might not be able to pay for expensive fillings out of their own pocket. Aesthetics is of rather subordinate importance particularly in fillings in the back teeth. "For highly aesthetic restorations, we risk material fatigue and even the loss of fillings. Should we not look instead for appropriate materials that offer more security though not 100% aesthetic and that can be paid for?" asked Prof. Noack.

In his subsequent talk, he stressed that megapascals and technical data are not what count in the development of composite materials. We should concentrate on the essential point: the 200 different aesthetic solutions available on the market would be no use to a national health patient if he is unable to pay for them.

However, none of the symposium participants wanted to let a fresh discussion of amalgam flare up again – they all agreed that this would lead nowhere.

### **Wish for antibacterial adhesive systems**

In contrast, many experts did not entirely follow Prof. Noack's conclusions. From various studies and long-term experience with dentine adhesive fillings, he concluded in his talk on the possibilities and trends in restorative materials and techniques that not all caries-associated bacteria can be removed even with extensive and careful excavation of a carious lesion. However, with careful use of modern adhesive systems and marginal gap-free fillings, secondary caries does not usually develop. Whether such excessive excavation is still

actually necessary should be considered or whether more of the carious dentine could be left and then virtually sealed with the adhesive system and filling material so that the caries cannot progress further. If minimally invasive methods are used, not only is more dentine preserved, thus producing better tooth stability, but the pulp is also less jeopardised, according to Prof. Noack. However, a premise is that no "nutrition" can penetrate through marginal gaps from the biofilm on the filling. In this connection, he also expressed a wish for antibacterial components in the adhesive.

In the following discussion, the need was expressed for further appropriate studies in view of the conflicting experiences in other studies and the imponderabilities of clinical practice before giving clinical recommendations.

### **New composite from Heraeus**

After nearly all the speakers invited to the symposium had expressed their wishes for new adhesive systems and composite materials, Dr. Wolfgang Eiselt, marketing manager, and Dr. Andreas Utterodt, R&D filling materials at Heraeus Kulzer, presented a new experimental nanohybrid composite, which is currently undergoing clinical tests under the name "NEUN" (NEw UNiversal composite).

The requirements a new composite material must meet were first established through extensive market studies, detailed discussions with researchers and intensive analyses, emphasised Dr. Eiselt. The research and development work then started. The new material has now been designed as a biocompatible universal composite for class I – V cavities. It has a new, bis-GMA-free plastic matrix and a particularly high filler density. A special low-shrinkage monomer was used with an additional cross-linking monomer. This compound reacts more readily and shows a higher polymerisation rate, said

Utterodt. Moreover, a higher filler content is possible: the filler density is 81 percent by weight (64 percent by volume). The shrinkage of the material is well below 2.2 percent by volume. However, compared with appropriate good composites, the shrinkage stress in particular is even further reduced through the flexible monomer structure.

The advantages of NEUN are high strength, low shrinkage, good handling, optimal packability, better and long-lasting high lustre, a universal shade system for natural aesthetics, a comparatively long working time under the operating light and good compatibility with the adhesive systems offered by Heraeus Kulzer. The shade concept is guided by the Vita Classical shade ring and works with three opacity stages – opaque dentine materials, universal materials and incisal materials.

“We have already had the new composite tested by several dentists throughout Europe“, said Eiselt. “All of them emphasise that the new material is good to work“.

These statements were confirmed by Prof. Antonio Cerutti (Brescia, Italy) when he presented the first clinical results with the new composite material. In his presentation he showed class V cavities in the split-mouth design using the microlayer technique with NEUN and GLUMA Comfort Bond or CeramX Duo and Prime&Bond. With a total of 60 restorations, he was unable to find any differences in shade matching. There were no complications or postoperative sensitivity. He also found very good surface high lustre. He had “a good clinical feeling“ with the new material, and his patients appear to have one too as none of them has complained so far, neither about the result nor about the postoperative symptoms that are otherwise typical of class V restorations.

## **Dentistry for “the afterlife”**

Tooth-coloured filling materials such as composites, compomers and glass ionomer cements can also be used to solve crime or identify dead bodies burned beyond recognition. Dr. Mary A. Bush, dentist and forensic scientist, and Peter J. Bush, expert in microscopy and material analysis of the State University of New York, Buffalo, USA, showed in their final enthralling presentation how forensic dentistry can establish the identity of dead persons with often only minimal amounts of filling materials. With a specially developed process, the material employed can be established and this can then establish the identity of dead persons using the dentist’s treatment records, explained Mary Bush.

The basis of their method, published in 2007 in the Journal of Forensic Sciences, is the inorganic components of the filling materials, the glasses, which contain elements such as zirconium, barium, yttrium etc. for reasons of better opacity. These components give the different filling materials an individual “fingerprint“ in energy dispersive spectrometry (EDS) and also in fluorescent X-ray spectrometry. Even in the case of materials with similar components, for example zirconium dioxide, individual spectra can be obtained for each material so that these can be identified reliably.

These inorganic components of the filling materials are preserved even at high temperatures. Even after incineration in a crematorium for two and a half hours at over 1,010 degrees Celsius, the residues can be found in the crushed ash – “for 1,000 grammes of ash there are about four grammes of filling material, which we can find and analyse by sieving, looking under the microscope or with fluorescent X-ray spectrometry“, according to Peter Bush. Material residues just two microns in size suffice. “Our process offers evidence-based

clues for identifying dead persons with a high degree of probability“, said Peter Bush.

So far, 35 modern composites are listed in a database that is also used by the FBI. The aim is to build up a global database of filling and dental materials which will also include imitation products, which are often used in third-world and fast-developing countries such as India and China.

### **Careful documentation**

However, there are two hurdles: on the one hand, all dentists must document the employed filling materials as precisely as possible in their treatment records. Secondly, the development of biomimetic filling materials with hydroxyapatite, as presented by Professor David Watts in his talk, would make such identification impossible. “We will probably no longer be able to distinguish this from the natural tooth“, according to Peter Bush.

### **Bridge between industry and science**

Dr. Martin Haase, managing director of Heraeus Kulzer, said at the start in his welcoming speech: “This symposium is an important opportunity for building a bridge between industry and science and intensifying the dialogue“. Not every question would be answered but many new ideas and suggestions would arise that could be implemented jointly. He proved to be right about this. Prof. Hickel too was happy about the lively exchange of ideas that took place that day.



**Auditorium**



**Prof. Albert Feilzer**



**Prof. Reinhard Hickel**

**The company:**

Heraeus, the precious metals and technology group headquartered in Hanau, Germany, is a global, private company with over 155 years of tradition. Our businesses include precious metals, sensors, dental and medical products, quartz glass and specialty lighting sources. With product revenues of €3 billion and precious metal trading revenues of €9 billion, as well as over 11,000 employees in more than 100 companies worldwide, Heraeus holds a leading position in its global markets.

Heraeus Kulzer GmbH, a subsidiary of the precious metals and technology group Heraeus, is one of the world's leading manufacturers of dental products, with headquarter in Hanau, Germany, and subsidiaries in the US, Europe, and Asia. As a system provider and service partner for dental offices and dental laboratories, with more than 1,500 employees worldwide, the company grossed EUR 336 million in sales in 2007.

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