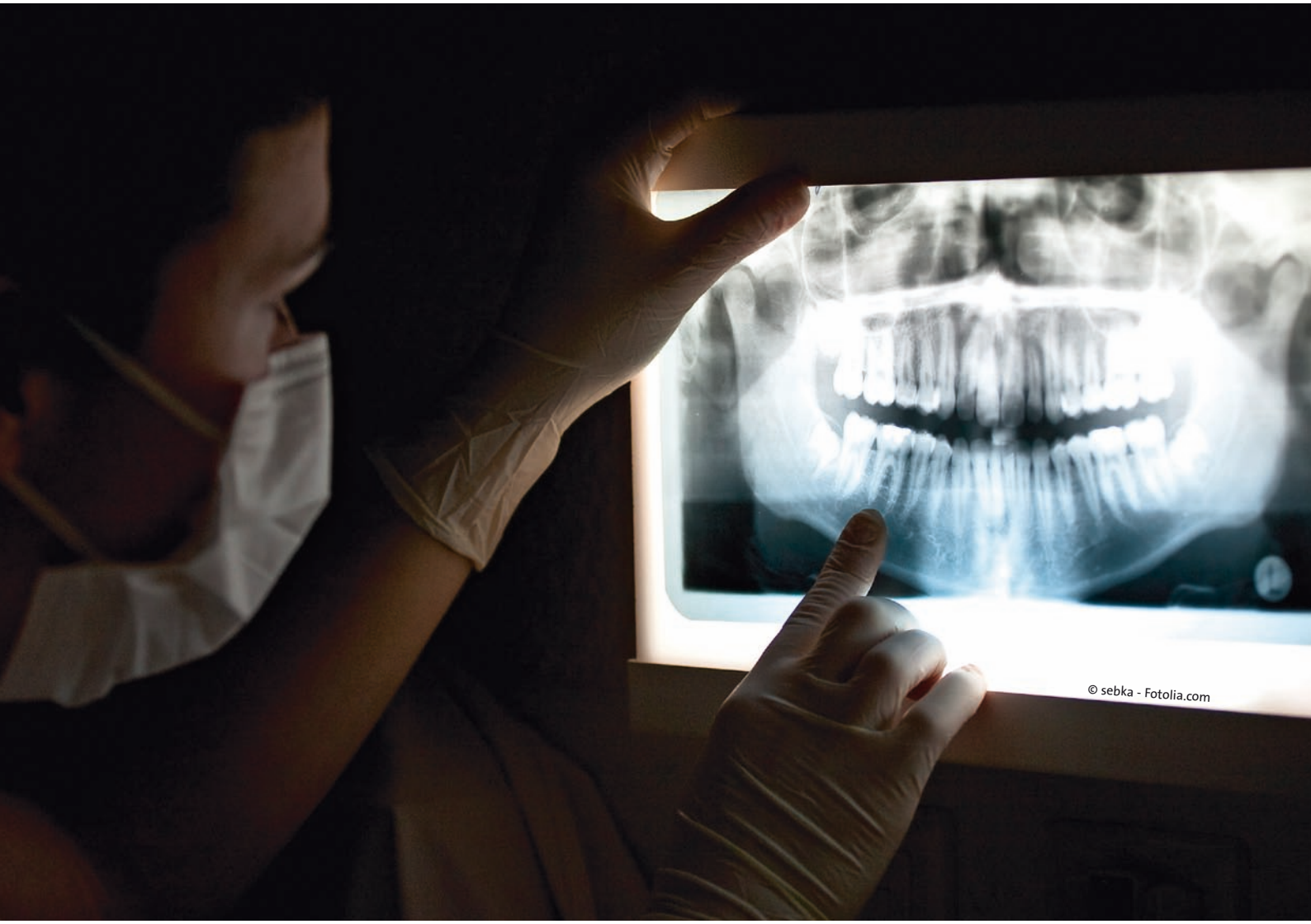
New material approaches in dental technology

Traditional materials used in dentistry, particularly precious metal alloys for crowns and bridges, are increasingly being swamped out of the market. These alloys serve as framework and are subsequently coated and aesthetically veneered with special ceramics. Due to their mechanical characteristics, the well-accepted mouth tolerance, the vast clinical evidence and their simple processing, precious metal alloys have been the material of choice in dentistry for many decades.

However, as a result of some of the material components' very high and volatile market values, like for e.g. gold and platinum, increasingly non-metallic alloys like cobalt-chromium are being pushed. Due to their advantageous market price, cobalt-chromium alloys are nowadays worldwide the most established material for fixed dental prostheses. The downside of precious metal-free alloys is that for crowns and bridges, they are by far not as aesthetic as their precious metal counterpart, usually a dark border is left between the crown and the gingiva.

The need for metal-free solutions in dental prosthetics already exists since quite some time. This trend gained even more importance through the recent amalgam discussions. Initial tests with full ceramic crowns instead of so called bonded metal ceramic crowns as described before, failed because of the



material's high brittleness. However, through computerization and modern manufacturing procedures, it is now possible to profitably process high-performance ceramics in dentistry for customized crowns and bridges.

Due to its very high stiffness, zirconium is applied in three to maximum four-piece bridge frameworks. Hence, the patient receives an aesthetical, biological, high class dental prosthesis. The disadvantage of the material is the considerably higher price compared to bridge frameworks out of cobalt-chromium.

Through technological advancements in the field of high-performance polymers, these materials are now being used wherever the highest demands are made of materials: automotive industry, aerospace, semiconductor technology and medical technology.

Exploring new paths

Outstanding properties also make high-performance polymers ideal for dentistry. Some products for temporary applications are being more and more established in the market: e.g. healing caps for dental implants or implant abutments. For the state-of-the-art manufacturing of crowns and bridges in milling machines, blocks out of high-performance polymers or PEEK are being offered.

A new chapter is now being written with the introduction of materials that have excellent properties for a diversity of applications. Cendres+Métaux is exploring new paths with Pekkton®, a top product among thermoplastics.

PEEK, PEKK – these terms are both numerous and confusing, but these materials all have one thing in common: they belong to the family of poly aryl ether ketones, known as PAEK for short. PAEK are high-performance thermoplastics which, thanks to their chemical structure, have high strength, stiffness and good resistance to hydrolysis and are, thus, suitable for extremely demanding conditions. When thermoplastics are processed, only the form and not their chemical structure is being changed. A crucial advantage when compared to thermoset polymers! The material also does not display any porosity or monomers.

The material PEKK is the latest generation of the PAEK (poly aryl ether ketones) family; it stands at the apex of the quality pyramid of thermoplastics.

Unlike PEEK, PEKK displays both amorphous and crystalline material properties. This makes PEKK particularly interesting. Thanks to its unique mechanical, physical and chemical properties, PEKK lends itself to a broader range of uses than PEEK:

- up to 80% higher compressive strength than PEEK materials,
- wider processing window of parameters than PEEK.

Mimicking nature is the future trend for dental products. Metals and ceramics, even if they are biocompatible, do not fulfill this claim. For instance, bone modulus matching may be important in applications where stress shielding should be minimized. By contrast, polymer-based products are increasingly acknowledged as better alternatives to stiff, rigid dentures in metal or ceramics solutions. Hence the extensive profile of material properties of Pekkton® naturally makes it ideal for different applications in the dental field. The natural high strength and low modulus of Pekkton® products may be increased by the addition of fillers. Stress-demanding applications are then made possible as the properties of human tissues are mimicked.

1) Removable denture with a framework out of Pekkton® instead of Cobalt-Chromium.

2) With tooth-colored composite veneered dental bridge from below: Pekkton® Bridge (pictured right), compared to a bridge in a cobalt-chromium metal alloy. Pictures: Cendres + Métaux

Stiffness, for instance, can be tailored to human hard tissues through the selection of fillers, their concentration and the processing technique of the resulting composite recipe.

Other important characteristics are:

- high tensile, fatigue and flexural strength,
- ideal dimensional stability,
- excellent wear and abrasion resistance,
- compatibility with all current sterilization methods,
- as well as radiotransparency.

The base material OXPEKK® passed the biocompatibility test over a period of 52 weeks according to ISO 10993 and is licensed by the FDA, the US regulatory authority. The biocompatibility of Pekkton®in accordance with Class USP VI was confirmed by BSL Bioservice Scientific Laboratories GmbH in Munich

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German Summary

Durch den technologischen Fortschritt von Hochleistungspolymeren kann der Einsatz des Materials insbesondere auch in der Medizintechnik laufend erweitert werden. Die herausragenden Eigenschaften prädestinieren Hochleistungspolymere auch für die Dentalmedizin.
Erste Produkte für temporäre Anwendungen beginnen sich im Markt zu etablieren: Zum Beispiel für die Implantologie Einheilkappen und Implantat-Abutments. Für die moderne Herstellung von Kronen und Brücken in Fräsmaschinen werden Blöcke aus Hochleistungskunststoffen oder PEEK angeboten. Mit dessen Einführung wird nun ein neues Kapitel geschrieben. Der Hersteller Cendres+Métaux geht dabei mit Pekkton®, dem Spitzenprodukt der Thermoplaste, neue Wege. Es basiert auf OXPEKK® von OPM, Oxford Performance Materials, Inc., USA. Der deutschsprachige Beitrag ist nachzulesen auf www.meditec-international.com/medi0511cen