Highly esthetic and high-strength monolithic IPS e.max CAD restorations

By Dr. Andreas Kurbad, Germany

IPS e.max CAD has had a lasting impact on the dental market over the last decade. The clinical reliability of hardly any other dental material has been so well documented. Highly esthetic and high-strength monolithic IPS e.max CAD restorations have become an alternative to metal ceramics and offer a comparable survival rate.

Introduction

As dental CAD/CAM systems have become established in dentistry, the vision of producing indirect restorations in the dental practice has become reality. An intraoral 3D-camera for digital impression-taking, an intuitive design software and a numerically controlled milling machine are the technologies that enable restorations to be created onsite in a short time compared to manufacturing in the dental lab. In addition to the time advantage, the digital method has also the benefit of saving resources, such as impression materials. Furthermore, the need for temporary restorations is eliminated.

Note: Adhesive bonding achieves the best values if it is performed immediately after tooth preparation.

Requirements placed on materials for chairside manufacturing

The technical prerequisites go hand in glove with materials that are suited for chairside manufacturing. Such materials should be strong enough to withstand a lifetime of use. However, very strong materials are difficult to process in a milling unit, especially since onsite manufacturing processes are expected to take only a short time. Furthermore, the material should also exhibit a tooth-like appearance in accordance with a certain esthetic sensibility. Onsite fabrication methods are not conceived for elaborate enhancements, such as ceramic veneers. The term “monolithic restoration” has become established in this context. This term describes a material that meets the requirement for adequate esthetic integration straight away, without necessitating any reworking. Furthermore, the materials should offer good conditions for adhesive bonding, especially as ever more tooth-preserving preparation techniques are preferred (Table 1).

Historical review

The beginnings of CAD/CAM fab-
IPS e.max® ZirCAD
The perfect combination of strength, esthetics and translucency

• Polychromatic MT Multi discs for efficiency and highly esthetic restorations
• High flexural strength and fracture toughness for a broad indication range
• Low wall thicknesses for less invasive preparations
• Three translucency levels (MO, LT, MT) for natural esthetics
**Fig. 20**: The teeth were restored to the correct proportions and the smile line was optimally increased.

**Fig. 25**: The preparations were effectively concealed under the new crowns (cut-back method) and the brightness of the teeth was considered easy to grind and polish and was suitable for use in the dental practice even if originally this was not the intended use of the material (Figs 12 to 15).

**IPS e.max CAD and its levels of translucency**

Driven by the excellent optical properties, users urged the manufacturer to increase the translucency of the blocks and to enable the fabrication of monolithic restorations. Vivadent responded by introducing IPS e.max CAD M0 blocks for creating monolithic restorations, especially for crowns, even if originally this was not the intended use of the material (Figs 12 to 15). LT stands for Low Translucency. These blocks ensured results that met a high esthetic standard, particularly when used in conjunction with the accompanying IPS e.max CAD Crystal/Shades and Stains characterization materials. With its user-friendly and compact design, the Programat CS (2007) furnace facilitated the applications at chairside. On the one hand, the LT blocks were sufficiently translucent to mimic the characteristics of the natural tooth structure and, on the other, they were sufficiently opaque to mask "problematic" substrate. Even today, this material may still be called a universal ceramic. Nonetheless, it may be regarded as a step forward that another level of translucency may be regarded as a step forward. This material was instrumental in establishing CAD/CAM systems for chairside applications. Vivadent launched the IPS e.max® CAD material on the market. Initially, it was available in MO blocks (Medium Opacity) with a relatively high opacity. These blocks were designed for the veneering technique (Fig. 1). This meant that this material was, in the main, inappropriate for chairside applications. However, this is not where the story ends. Initial experiences showed that the material was dotted and, at times, unfavourable geometries in the design of the cavities. The introduction of the ProCAD blocks (1998) did not bring the decisive breakthrough either. This material was based on leucite-reinforced glass-ceramic and featured a flexural strength of 140 MPa. The blocks are still available in an optimized version as IPS Empress® CAD or as IPS Empress CAD Multi blocks (199 MPa) to this very day. Although these materials produced good to very good long-term clinical results, they always entailed a risk for failure in the form of fractures.

**Introduction of IPS e.max CAD**

A new category of glass-ceramic materials brought about the decisive improvement in 2005. Lithium disilicate was available in MO blocks (Medium Opacity) with a relatively high opalescence and fluorescence. It was the flexural strength of 360 MPa, which was clearly superior to all materials used in this segment so far. Soon we began to use the IPS e.max CAD M0 blocks for creating monolithic restorations, especially for crowns, even if originally this was not the intended use of the material (Figs 12 to 15).

**Fig. 17**: As the result was esthetically unsatisfactory, the teeth were prepared using a planned, minimally invasive procedure.

**Fig. 21**: The 3-year check-up did not show signs of ageing.

**Fig. 26**: The final result shows a pleasing esthetic appearance.

**Fig. 27**: Preparation for a three-unit bridge with an ovate pontic design.
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with an appropriate luting material, this blocks allowed the shade of the substrate to be integrated into the overall optical effect of the restorations. This meant that partial crowns and veneers could now be created with ease directly onsite in a single visit. The trend towards ever less invasive procedures led to the introduction of still another variant of IPS e.max CAD: the Impulse materials (2013). Impulse Opal O and O2 are ideal for fabricating monolithic restorations with the aim to reproduce dental enamel. Outstanding results can be achieved with comparatively minimal effort. As many users had difficulty in classifying the Impulse blocks appropriately in the product portfolio, some parts of the assortment were taken over into the recently created category MT (Medium Translucency, 2015). The IPS e.max CAD materials of the medium translucency category are mainly used to improve brightness values. Altogether, five different levels of translucency are available today. With this “toolkit”, monolithic restorations of various translucency are available today. With this “toolkit”, monolithic restorations of various translucency are available today. With this “toolkit”, monolithic restorations of various translucency are available today.

Range of indications for chairside applications

The range of indications for IPS e.max CAD evolved in tandem with the provision of the blocks. The LT variant is the first choice for crowns and indications that involve “problematic” substrates. Larger blocks enable the onsite fabrication of bridges (up to the second premolar as the terminal abutment). In this case, the processing time is longer than for single-tooth restorations. With the HT variant, inlays, onlays and partial crowns can be manufactured to a high-esthetic standard.

At IDS 2017, Ivoclar Vivadent launched the IPS e.max CAD 530 MPa initiative. Eleven years of continuous quality testing have shown that IPS e.max CAD provides actually a mean biannual flexural strength of 530 MPa. This is also reflected in the consistently positive results of many scientific studies on the survival rate of IPS e.max CAD restorations (literature). In view of the consistent further development and favourable long-term clinical results, the minimum thicknesses recommended for adhesively cemented IPS e.max CAD crowns have been reduced to thinner dimensions. This means that preparing the teeth is easier and more tooth structure can be preserved. It also allowed the category of indications to be extended to include occlusal veneers, which have come to play a key part in raising the bite in the posterior region.

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The future lies in the use of new technologies. The PrograMill One milling and grinding machine will deliver significantly better results in less time as it incorporates innova-tive new technology. For instance, the 5-axis turn milling technology (XT) uses a robotic arm, rather than a milling motor, to move the workpiece. This enables a consistent milling and grinding procedure with many degrees of freedom and increased levels of accuracy. Only a minimal amount of resowing is required after the machining process. As the material is considerably easier to process when it is in its pre-crystallized blue state, corrections should be implemented directly at the grinding stage. A try-in can be performed before the crystallization process is carried out if the restora-tion is machined onsite (Figs 27 to 29).

Crystalization is a mandatory step in the IPS e.max CAD workflow. The restoration is secured on a special firing tray with the help of support pins and firing auxiliary paste (IPS Object Fix). Polishing is basically possible. However, it is also possible to apply a spray glaze or glazing paste. Individualized shade characterizationse can be created with IPS e.max CAD: Crystal/Shape/Stains material at the same time as the glaze is applied. The crystallization process takes 15 minutes in the best case when using the spray glaze (speed crystallization), otherwise it takes 25 minutes. Developed specifically for the chairside method, the Programat CS furnaces (e.g. the new Programat Ci4 universal furnace) provide optimum results in the shortest possible time and are therefore a sensible recommendation (Figs 30 to 34).

Thanks to the high strength of the material, several options are available for seating the restorations. Adhesive bonding should always be the preferred method. Conventional luting material is also available but requires a repetitive preparation pattern, which is considered outdated by today’s standard.

Monobond4 EtchPrime (etching and silanating in a single step) can be used for conditioning the ceramic. Which kind of luting material is used depends on the clinical situation. Posterior crowns can be seated quickly and easily using the self-adhesive SpeedICEM® Plus. For higher esthetic requirements, Varilink Esthetic should be employed. This material is available in a dual-curing and purely light-curing version. More information and guidance is provided by the Cementation Navigation Sys-tem (CNS).

Conclusion

IPS e.max CAD is the gold standard for chairside restorations (Figs 35 to 39). Together with the Programat furnaces designed for IPS e.max CAD and the corresponding cementation materials, a coherent system that ensures the necessary robustness in a wide range of applications has been developed. IPS e.max CAD sets benchmarks for efficient, tooth-preserving all-ceramic restorations that offer a high level of clinical reliability. The new zirconium oxide blocks (IPS e.max ZirCAD LT) complete the overarching IPS e.max system, in line with the motto IPS e.max – all ceramic, all you need.

Editorial note: Literature is available on request from the editors.