Mastering the art of dental technology

By Marc Chalupsky, DTI

SINGAPURA/BAD BOCKLET, Germany: Singapore and Germany are about 10,000 km apart. As Singaporean dental technicians and dealers discovered at this year’s International Dental Exhibition and Meeting (IDEM), the world’s most comprehensive range of dental laboratory products can be found at DT&SHOP, located in the town of fluid Bocklet about 200 km north-west of Nuremberg. Owing to the company’s latest inventory and delivery systems, orders arrive in Singapore and other Asia-Pacific countries within three working days. DT&SHOP has big plans for this thriving dental technology market.

According to a recent Transparency Market Research report, the Asia-Pacific dental laboratory market is projected to expand at a substantial rate in the next five years. Driven by rising dental tourism and a growth in the number of dental laboratories, the domestic sector will also see an increase in export demand, particularly regarding bridges and implants. Local dealers have yet to be prepared to satisfy demand, particularly regarding CAD/CAM technology. As one of the world’s main dental laboratory suppliers, DT&SHOP will soon provide a convenient solution: “We will work closely with these smaller and medium-sized dealers in the region by giving them access to the company’s product and delivery system,” said Dr. Nicolas Rohde, head of the Dental and International Division. “This will also include advanced marketing and educational support. The new digital possibilities allow us to work with partners and clients anywhere and anytime.” With a 96 per cent product availability, eco-friendly packaging and competent customer service, the company has proved itself to be a reliable partner for local dealers.

This year, DT&SHOP took the next step towards securing a major position in the Asia-Pacific market, by exhibiting at IDEM Singapore 2016. With a 50 m² booth, the company showcased its wide range of dental laboratory products from leading manufacturers. As a dental supplier, DT&SHOP also presented the new FINOCAM A5 five-axis milling unit and the FINOSCAN RELATION high-quality optical 5D scanner. Most dental technicians at IDEM were impressed by our FINO CAD/CAM solutions. In fact, our FINO brand covers most of the dental laboratory needs, including orthodontic boxes, partial denture alloys, duplicating and addition-curing silicones, modelling wax, relining units, porcelain brushes and much more,” explained Roer. “I think that we have quite successfully mastered the art of offering the complete range of dental technology.”

Artists and dental technicians share a talent for colour, aesthetics and technical complexity. It therefore comes as no surprise that DT&SHOP’s corridors are filled with masterpieces, inspirational and vivid artworks from around the world. Roer has had a passion for art for most of her life. Her latest acquisition, a set of paintings from Canada, is awaiting a suitable space in one of the company’s new course and laboratory rooms. In 2010, she travelled to Vietnam, to purchase several paintings from local artists. The Asia-Pacific region and Vietnam in particular are known for their lively art scene. “Art has always been very important to me,” said Roer. “Our visitors do not rush through the aisles of the building. They stop and see the beautiful work by artists about 10,000 kilometres apart.”

Materials and systems for all ceramic CAD/CAM restorations

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Dental crowns have been used for decades to restore compromised, heavily restored teeth, and for aesthetic improvements. New Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) materials and systems have been developed and evolved in the last decade for fabrication of all-ceramic restorations. Dental CAD/CAM technology is gaining popularity because of its benefits in terms of time consuming, materials savings, standardisation of the fabrication process, and predictability of the restorations.

The number of steps required for the fabrication of a restoration is less compared to traditional methods (Fig. 1). Another benefit of CAD/CAM dentistry includes the use of new materials and data acquisition, which represents a non-destructive method of saving impressions, restorations and prostheses.

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of this material is that it can be used as a milled dense composite that was free of polymershrinkage but can be sintered or glazed [9].

In early 1998, IPS Procera (Ivoclar Vivadent) was introduced as a leucite-reinforced ceramic, which was similar to IPS Empress but with a finer particle size; this material was designed to be used with the CEREC system (Sirona Dental) and available in different shades [2]. More recently, the introduction of IPS Empress CAD (Ivoclar Vivadent) and Paradigm C that according to the manufacturer (IPS Empress CAD) is a 40 to 45 percent leucite-reinforced glass ceramic with a fine particle size [10].

To overcome esthetic problems of most CAD/CAM blocks having a monochromatic restoration, a different version was developed as a multicoloured ceramic block, which was called VITA TriLuxe (Vident) and also IPS Empress CAD Multilite, the base of the block is a dark opaque layer, while the outer layer is more translucent; the CAD software allows the clinician to position or align the restoration into the block for the desired outcome of the restoration [11,12].

In 2014, the Enamic (VITA) material was released as a ceramic material infiltrated with a reinforcing polymer network that has the benefits of a ceramic and resin in one material, but no clinical data are available [4].

Alumina-based ceramics

Alumina blocks (Vitablocs In-Ceram Alumina, VITA) are available for milled crown and bridge restorations. A milled ceramic framework is connected to a porcelain veneering. The material is intended to be used in the interocclusal space [22]. This feature limited the use of these ceramies until 1971 when Reth and Gupta developed the yttria- tetragonal zirconia polycrystal (Y-TZP) ceramic which is mostly limited in its use in order to minimize this effect [10].

One of the most interesting properties of zirconia is its transformation toughening. According to Kelly (2008) describes it as: A phenomenon that happens when a fracture takes place by the transformation of an unstable phase in the material into a more stable phase at a lower temperature (that increases the energy of the crack propagation) [4].

Zirconia restorations can be fabricated from fully sintered zirconium oxide or partially sintered zirconium oxide blanks (green-state). Proponents of milling partially sintered zirconia claim that fitness of restorations is better because it avoid volumetric changes during the fabrication process. On the other hand, the partially sintered zirconia (Fig. 4) is easier and faster to mill and proponents of milling partially sintered blanks claim that milling partially sintered zirconia at the restoration during the milling process and it also requires more sophisticated and improved milling machines; micro defects or surface flaws can affect the final strength of the final restoration. In addition, it can improve the contact between the marginal areas, however further research is needed about this topic [10].

One of the first systems that used zirconia was In-Ceram Zirconia (Vident), which is a modification of the In-Ceram Alumina but with the addition of partially sintered zirconia oxide to the composition. Recently many companies have introduced zirconia into the CAD/CAM workflow due to its mechanical properties which are attractive for restorative dentistry, some of these properties are: high strength, toughness, radiopacity for marginal integrity evaluation, and relatively high elastic modulus [22].

Different manufacturers are using zirconia as one of their main materials such as: Ceramill Zolid (Amann Girrbach), Zirconia (Amann Girrbach), Cora- con (DENTSPLY, BruxLab (Gleidwasser Labnoratories), IPS Zirkad (Ivoclar Vivadent), Zenostar (Ivoclar Vivadent), InCoris Z (Sirona Dental), VITA In-Ceram YZ (Vident), among others. Companies have introduced new materials that are combination of zirconia with improvement to its properties.
in different clinical situations. Lava Plus, for example, is a combination of zirconia and a nano-ceramic.

### CAD/CAM systems

A wide range of CAD/CAM systems are offering CAD/CAM systems that generally consist of a scanner, design computer and a milling machine or 3-D printer. Laboratories are able to receive digital impression files from dentists or use a scanner to create digital models that are used for the fabrication of CAD/CAM restorations. The CAD/CAM systems vary in speed and accuracy. Milling machines vary in size, speed, axes, and also in which restorative materials in relation to their milling characteristics and capabilities can be cut. In this category milling machines continue to be classified as wet or dry, depending if the materials require irrigation.

The development of dental CAD/ CAM systems occurred at the same time with the introduction of the Sophost system developed by Dr. Francois Durst. A few years after that event, Dr. Werner Mormann and the electrical engineer Marcus Brandtius developed CEREC’s system. It was the first full digital dental system created to allow dentists to design and fabricate in-office restorations. Since then, the continuous evolution of systems dedicated to this field has continued and has exponentially increased in the last decade [4].

CEREC systems have evolved into CEREC Bluecam scanners, accurate as 17 microns for a single tooth, have been reported by authors using a special CAD/CAM system. CEREC Omnicam was introduced offering true color digital impressions without the need of using plaster models. Ina recent study by Neves et al. (2015) on the marginal fit of CAD/CAM restorations fabricated with CEREC Bluecam, they compared lithium disilicate single unit restorations to heat-press restored restorations and 83.8 percent of the specimens had a vertical gap with a width less than or at least 53 microns [5].

The CEREC Inlab CAD software (Si- ron Dental) was designed for dental laboratories for a wide range of dental capabilities that can be combined by the user. This allows the designer and restorer to design the restoration, once this process is completed, the file can be sent to a remote milling machine or a milling centre for fabrication in a wide range of materials.

The Procer system, introduced in 1994, was the first system to provide fabrication of a restoration using a computer network connection. According to research data the average ranges of marginal fit of these restorations are between 44 μm and 64 microns [6]. A computer integrated crown reconstruction system (CICERO) introduced in 1999 included a rapid custom fabrication of high-strength alumina coping and semifinished crowns to be delivered to dental laboratories for porcelain layering and finishing [6].

Another system that was developed years before was the Celay system, which fabricated feldspathic restorations through a copy-milling process. The system duplicated an acrylic resin pattern replica of a restora tion. Zirconatoll developed a similar system in the late 1990s which was able to copy-mill zirconia patterns and restorations out of a replica of the restoration. Some of the main concerns from clinicians about all-ceramic CAD/CAM restoration systems are that they do not allow for a good integration between parts and probably lead to the incorporation of new software in the workflow. Further research is required to understand the importance of these systems.

The incorporation of new systems into current systems has made the difference of the software in the workflow. Further, the virtual configuration of the die spacer between the tooth and the restoration is essential for the accuracy of the marginal adaptation and has to be calibrated for each of the systems. The accuracy of CAD/CAM restorations is directly related to the parameter from the design software and also related to the intrinsic properties of the CAD/CAM system [6].

Conclusion

This review of current and past literature regarding the evolution, characteristics, and marginal fit of all-ceramic CAD/CAM restorations and materials systems and shows that it is possible to fabricate restorations with the same marginal fit expected from conventional methods and within the range of clinically accepted restorations. When comparing both methods the advantages of using CAD/CAM technology is to increase the precision of the system, to allow the fabrication of a restoration using a minimum amount of restorative materials. The comparison of systems and protocols does not allow us to give a definitive conclusion.

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