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special update equipment

Scientific Information

Topic: **QTK Muffle Technology**

Title: Scientific and furnace-related technical aspects of the new heating muffle technology (QTK)

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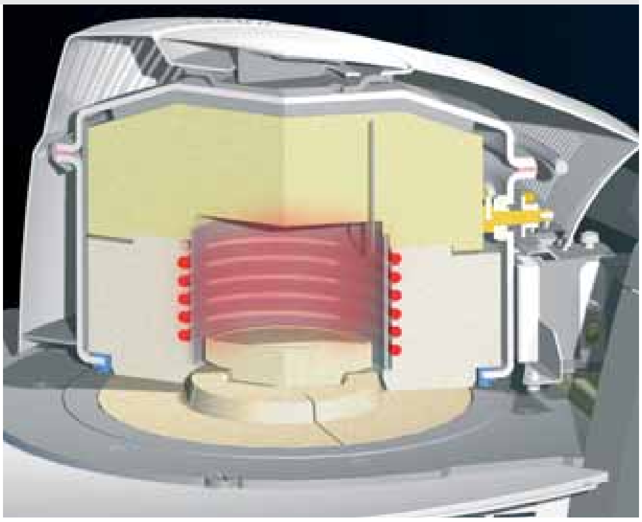

1. Introduction

Extremely high requirements are placed on heating elements. In addition to an excellent and homogeneous heat distribution for optimum sintering of dental ceramic materials, the heating elements should also feature a particularly long service life and reliable heating performance across the entire temperature range. Therefore, a new and extraordinarily powerful heating element, which meets all these requirements, has been developed for the new Programat furnaces P300 and P500.

2. Differentiation and function of heating elements

Ivoclar Vivadent AG uses the heating element types shown in Figure 1. Given the missing quartz sheath, the Programat furnaces P95, P80, P100, and P200 demonstrate a very direct heating effect. Furthermore, the heat does not develop evenly. The situation has been improved with the Programat PX1 heating element, in which the heating wire is guided through a quartz glass tube.

In a QTK heating element like the one used in the Programat P300 und Programat P500, a quartz glass cylinder has been placed in front of the heating element. The mass of this quartz glass cylinder provides two positive effects. Given the filter effect of the quartz glass in the infrared range, the quartz glass cylinder itself is heated up. Subsequently, the temperature is evenly distributed to the firing chamber via the quartz glass cylinder. Since the quartz glass cylinder demonstrates thermal conductivity, the heat is evenly transported to all the involved heating coils and spirals. In this way, the corresponding stress is equally distributed to the entire heating element, which positively influences the service life.

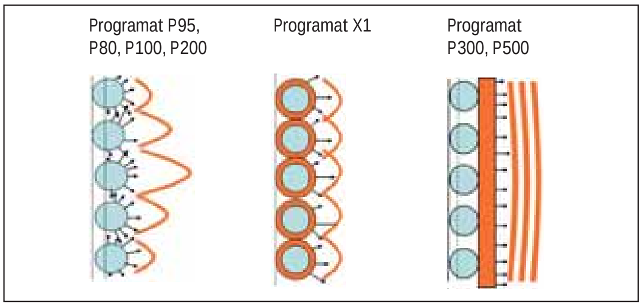

Fig. 1: Cross-sections of different heating elements of Ivoclar Vivadent furnaces

3. Principle

For a better understanding, the function of the quartz glass cylinder placed in front of the heating element is best described with a candle as an example. If the temperature is measured directly above the flame of a candle, the measurement will show the highest temperature in the immediate vicinity of the flame. Only slightly to the side of the flame, the measured temperature rapidly decreases. There exist steep temperature gradients or temperature inhomogeneity, respectively, within the flame. Now, if a thin metal plate that is clearly larger than the frame is held directly above the flame, the metal plate will very evenly heat up due to the thermal conductivity of the metal. The heat is also given off laterally. A homogeneous temperature distribution occurs above the metal plate. A point source of heat is thus transformed into a large-area heat source. The same principle is also applied, for example, in a gas-powered barbecue grill, in which a localized gas flame heats up a metal plate, which, in turn, evenly distributes the heat to the items to be barbecued.

The application of this principle coupled with the interplay of various other constructive parameters permitted to achieve a very homogeneous temperature field in the firing chamber of the Programat P300 and P500.

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4. Measuring the temperature distribution in a firing chamber

In cooperation with a Swiss university, Ivoclar Vivadent has developed a measuring carrier to measure the temperature gradients in a cylindrical firing chamber. The use of this measuring carrier provides an excellent overview of the place- and time-related temperature distribution in the firing chamber in various temperature ranges. At the same time, these data were used to optimize the Programat firing chamber. A computer model permits the 3D representation of the temperature distribution at different times in the tested firing chamber.

Below, the temperature distribution in the firing chamber of the Programat P100 is compared to that in the Programat P300/P500. This comparison shows the temperature at the moment when the holding time is reached. The red 3D body represents the temperature zone of 980 °C within +/- 5 K.

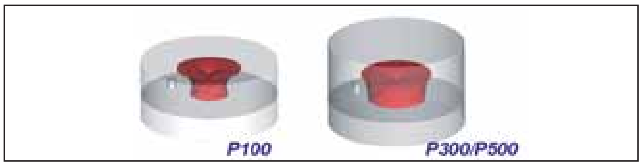

Fig. 2: P100 compared to the P300 / P500

The difference is clearly visible by comparing the tooth located on the left in the firing chamber diagrams (Fig. 2). With the QTK heating element, a clearly more homogeneous temperature distribution is achieved. The execution and results of the measurements regarding the temperature distribution in various firing chambers are described in the scientific articles mentioned below.

5. Performance of the QTK heating element during its service life

The new dimensions of the design type of the QTK heating element also ensure excellent properties over the entire service life of the heating element. The heating coil resistance does hardly ever change, even after many operating hours. In this way, consistent heating performance and quality is achieved, which is also reflected in the heat-up speed.

Figure 3 below shows the measured temperature gradients of a P300 / P500 heating element at the end of its service life for comparative purposes. As can be seen, the Programat P500 takes less than 6 minutes to heat up from the stand-by temperature of 400 °C to a firing chamber temperature of 1200 °C.

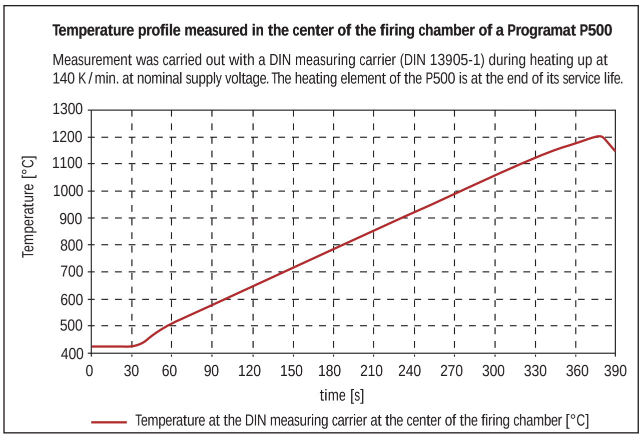

Fig. 3: Temperature gradient achieved over the entire temperature range

6. Sturdiness and reliability

The new QTK heating element provides consistent heating performance over its entire service life and thus constant temperature control. Consequently, it goes without saying that the process control is also ensured. Moreover, high temperature gradients of 140 K / min. are achieved over the entire operative temperature range of 400 °C to 1200 °C. This also becomes apparent by the consistently short firing times, which, in turn, considerably reduce the processing times.

7. Conclusion

Together with other constructive factors, the new QTK heating element (Fig. 4) significantly and verifiably contributes to a better temperature distribution in the firing chamber.

Fig. 4: QTK heating element

Service life tests have shown that the QTK heating element can be used for longer periods of time and, most of all, at a consistently high quality. In this way, the performance of the furnace remains unchanged for all firing cycles, which is an important basis for the daily work of dental technicians.

Literature:

Prof. Dr. R. Biffar, OA Dr. Th. Klinke (2004) „Dentalkeramiköfen“ Zahntechnik Mag 8, 12, 938-946

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