special update equipment

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Temperature calibration

The Automatic Temperature Checking Set 2 (ATK 2) for the Programat P500 opens up new calibration options

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In keeping with the current trend of dental materials development, ceramic furnaces for the fabrication of metal-ceramic and all-ceramic dental restorations are usually operated at a temperature range from 600 °C to 1000 °C. However, there has been a clear trend towards the use of low-fusing ceramic materials. Therefore, the challenge was to create a device which enabled highly accurate calibration of dental firing chambers in the low temperature range. This resulted in the development of a new temperature calibration aid for the Programat P500, which relies on the principles of the well-known silver test, but is based on the use of high-purity aluminum.

Fig. Programat P500

1. Introduction

It is common knowledge that ceramic furnaces for dental applications need to be calibrated at regular intervals. This necessity for calibration has various causes, eg deposits in the firing chamber, the impact of chemical substances segregated by the processed material, etc. A number of methods are currently used to calibrate furnaces. Ideally, they should enable operators to conduct the calibration in their laboratory and allow them to adjust the temperature in the furnace to that of the specifications of the manufacturer in a simple procedure that provides the desired accuracy.
Unfortunately, the term "calibration" is used incorrectly by some manufacturers. Calibration does not refer to a mere

temperature offset or change of the temperature factor of a software. Rather, calibration entails comparing a highly precise measuring system which uses the extremely accurate melting point of silver (961.8 °C) as the standard with the measuring system of the furnace. In many cases, the calibration process also includes the subsequent adjustment of the temperature based on the calibration result.
The calibration procedures from Ivoclar Vivadent described below all include readjustment of the temperature.

2. Advantages and disadvantages of the different calibration procedures

Calibration procedures vary tremendously. At Ivoclar Vivadent, the silver test is viewed as the preferred method for calibration and temperature adjustment. Highly precise thermocouples are employed both in research and development as well as production. Apart from the silver test, experienced operators can also use the aesthetic appearance of the fired restorations as a basis to decide whether the temperature needs to be adjusted. Other methods include the use of gold or process temperature control rings (PTCR). The calibration procedures available differ considerably with regard to the procedure, time and effort involved. Incorrect interpretation of the calibration results is a common source of error in manual procedures. A well-known disadvantage of temperature calibration and adjustment with the silver (Ag) test is that calibration is limited to only one temperature point which is 961.8 °C. Thus overall adjustment of the temperature is only possible with the help of a temperature offset or factor. The farther away from this temperature point one gets, the higher is the risk of the inaccurate control of temperatures. Due to the increasing trend towards low-fusing ceramics and the ever-increasing importance being attached to precision, a solution was sought that relies on the principles of the silver test, but is applicable to the temperature range in which low-fusing ceramics are fired (750 °C at present).

3. The properties of aluminum

When one looks at the table of elements, it becomes obvious that aluminum (Al) is the only suitable metal because of its availability in high purity and its highly accurate melting point of 660.4 °C. What is problematic about Al is that in contrast to silver, it maintains its shape in a molten state. This is due to the thermally and chemically resistant oxide layer that forms or already exists.
In an attempt to find a solution to this problem, we discovered a very special property or physical effect that occurs in conjunction with Al. Contrary to all other metals, aluminum shows a sudden volume increase of 7 % when it reaches its melting point.

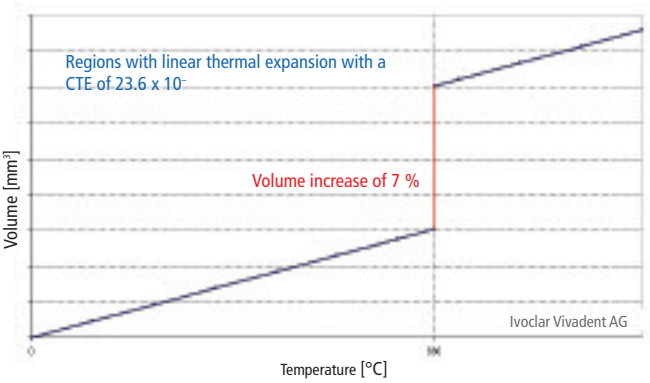


Fig 1: Thermal expansion of aluminum as a function of temperature

4. Functional principle of calibration with aluminum

The idea behind the new, patented method is that the aluminum is kept in a metal container with an opening of a defined size. An additional metal contact is positioned at a specific distance opposite the opening. When the melting temperature of 660.4 °C is reached, the only way for the

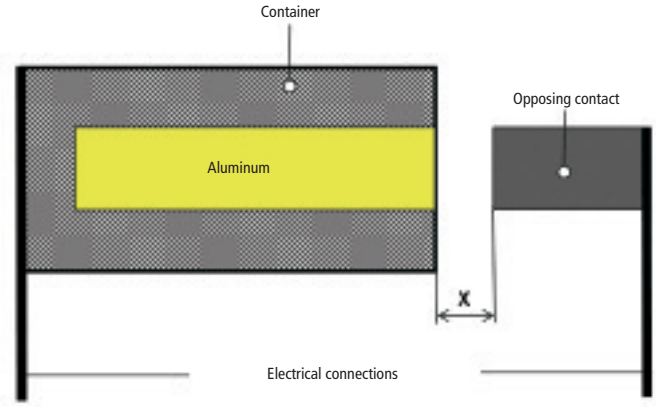


Fig 2: Open aluminum contact

aluminum to expand is through the opening. In the course of this process, the aluminum bridges the gap between the container and the opposing contact. An electrically conductive metal connection is created.

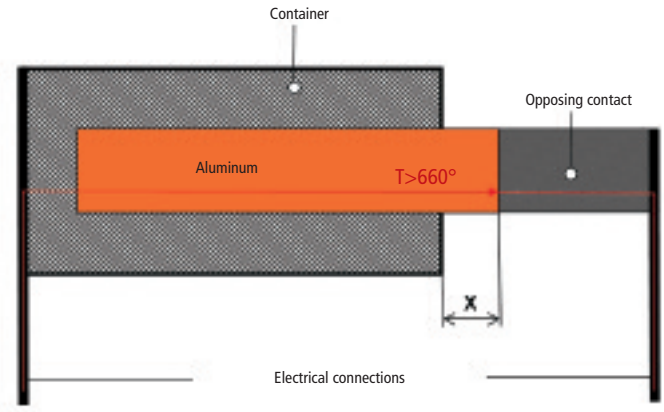


Fig 3: Closed aluminum contact

5. The principle of double-range calibration

Silver, when employed in the same manner as in the Automatic Temperature Checking Set 1 (ATK 1) for EP600, opens an electrical contact when the melting temperature is reached. As aluminum is capable of closing an electrical contact, the aluminum and silver contacts can be ideally combined. A serial connection of the two contacts enables us to conduct what is called double-range calibration. Calibration in the temperature range around 660 °C and around 961 °C is accomplished in one calibration cycle. Based on these two temperature points, the temperature curves in the most popular operating ranges can be reliably adjusted. Figure 4 shows the ATK 2.
In Figure 5, a radiograph of the aluminum contact is displayed.

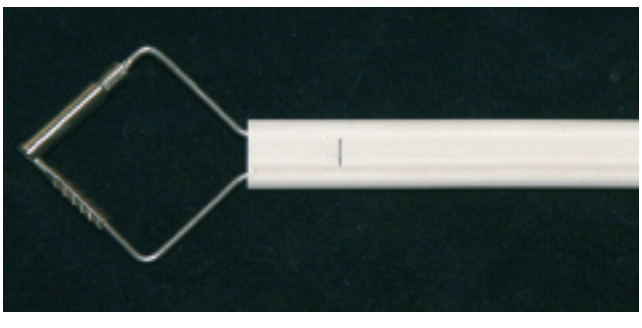
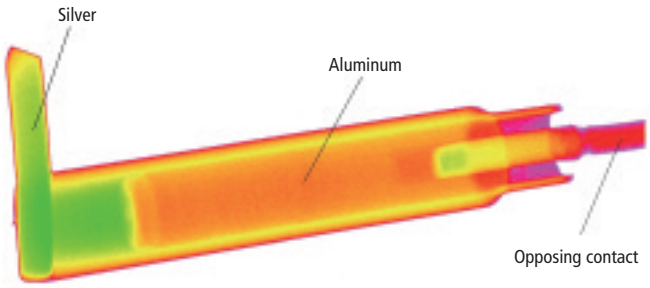


Fig 4: ATK 2 test sample



Ivoclar Vivadent AG and Dage Test Systems, taken with the XD7600 X-Ray System

Fig 5: Radiograph of an aluminum contact

6. Verification of precision

In order to verify the precision of the new calibration method, a Programat P500 porcelain furnace was assessed according to DIN Guideline 13905-1 "Qualitätssichernde Massnahmen zur Kalibierung von dentalen Brennöfen - Teil 1: Dynamisches Messverfahren mit serparatem Thermoelement" (Quality assurance measures for the calibration of dental ceramic furnaces – Part 1: Dynamic measurement procedure with separate thermocouple) following calibration and adjustment using the Automatic Temperature Checking Set 2 (ATK 2). The graph below shows the excellent results achieved in the test.

Temperature control of Programat P500 (serial number: S100) after calibration with ATK 2, tested according to DIN 13905-1

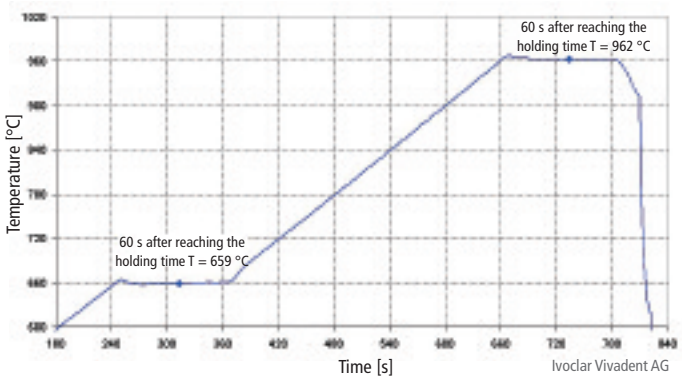


Fig 6: Control survey after calibration with ATK 2

7. Fully automatic calibration using ATK 2

The automatic calibration of a Programat P500 furnace with ATK 2 is very simple. The calibration sample is inserted into the slot in the base plate. After starting the calibration program, the calibration value for the low and high temperature ranges is automatically generated by the furnace. The duration of the calibration cycle is approx. 100 minutes. Therefore, we recommend that calibration be conducted during off-hours. Moreover, it is advisable to conduct a cleaning program prior to calibration. If a cleaning program is run, it should always be followed by a calibration cycle and an adjustment of the temperature.

8. Conclusion

By utilizing the properties of aluminum, we have succeeded in creating a means for calibrating and adjusting the temperature of ceramic furnaces over the entire operating range. Calibration at regular intervals ensures that the ceramic furnace provides a highly accurate basis on which to conduct day-to-day work procedures in the dental laboratory.

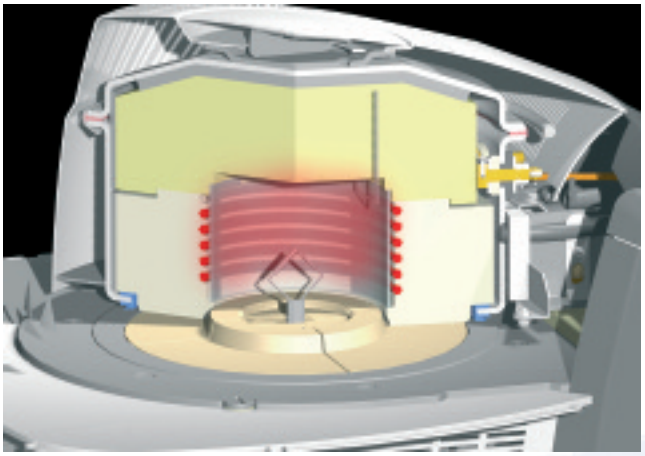


Fig 7: Cross-section of the furnace head of Programat P500

Literature:

DIN 13905-1 «Qualitätssichernde Massnahmen zur Kalibrierung von dentalen Brennöfen – Teil 1: Dynamisches Messverfahren mit separatem Thermoelement»

DIN 13905-2 «Zahnheilkunde – Dentalkeramikofen – Teil 2: Anpassung des Brennprogrammes mittels Brenngradbestimmung»

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