

## Application Report: Non-contact Temperature Measurement at Soldering and Brazing Facilities

*Inductive heating is a well-proven method for soldering diamond composite segments to stone saw blades. This holds true for both high-volume production as well as for repair work. Pyrometry is the only temperature measurement technique able to meet the high measurement standards and thus the high product quality the industry demands.*

### **Brazing and Soldering - an ancient technique**

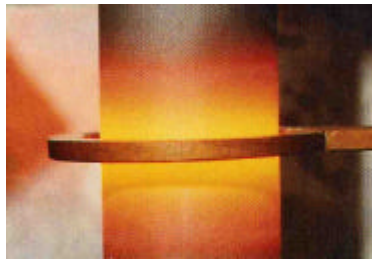
Thermal fusion as a method to create an adhesive joint between two materials has been around for over 6000 years. In soldering and brazing, the filler material is brought to the liquid phase through melting but the parent materials are not heated beyond the solidus temperature. Welding, on the other hand, is a fusion process in which the materials to be joined are themselves heated to the melting point. Soft-soldering refers to a working temperature below 450 °C, and above that the process is called brazing. High temperature brazing above 900 °C is conducted in a vacuum or an inert gas atmosphere. There are various methods of heating: by flame, arc, furnace, solder bulb, alternating magnetic field or by electric current.

### **Principle of Induction Heat**

Induction heat soldering or brazing is not as well-known as other soldering methods. The operating principle of high-frequency induction heating consists of placing an electrically conductive material in a fluctuating electromagnetic field.

The induction heating power supply sends alternating current through a single or multiple induction coil, thus generating a magnetic field. When a workpiece is placed within the induction coil and enters the magnetic field, eddy currents are induced within the workpiece, generating precise and localised heat.

An induction heater works according to the same principle as a transformer: the inductor functions as the primary winding and the workpiece as the secondary winding.



*A single induction coil heating a workpiece*

### **Advantages of Induction Soldering/Brazing**

Due to the highly efficient heating process—virtually heating from the inside out—induction soldering and brazing is an ideal technique. Unlike lasers, induction heating is still efficient when the position of the brazed or soldered joint varies.

Electromagnetic induction provides more rapid and uniform heating than a soldering iron. Whereas soldering tips will wear out and need to be replaced often, an induction loop is virtually wear-free because it is a non-contact method.

Induction soldering and brazing is ideal when it is necessary to define or limit the heat to a specific region on a workpiece. Induction equipment requires less capital investment and the simplified maintenance means reduced operating costs, thus providing additional advantages over other soldering and brazing methods.

In the past, induction heating was primarily used for creating heavy or wide joints. Today, by using finer induction loops, through non-contact temperature measurement technology as well as more precise feeding and shaping of the filler metal it has become increasingly possible to employ induction heating for extremely small parts such as printed circuit boards and substrates.

Because of the highly localised heat, the solder joint rapidly reaches the required temperature for fusion without risking damage to the workpiece. Induction brazing is economical as well, and due to its high repeatability, this method is perfectly suited for automated, high-volume processes.

### **Induction brazed diamond segments**

Fully automatic brazing machines are employed to bond carbide and diamond segments of various sizes and shapes to tools such as circular saw blades. This modern technology has made it possible to fulfil today's high standards of industrial process control and provides automatic compensation of material tolerances.



*Fully automatic brazing machine for circular saw blades*

The saw blade as well as the diamond segments act as the short-circuited winding. Eddy currents are induced within the saw blade and the diamond segment, generating precise and localised heat. The silver solder applied between the saw blade and the segment joins the two when the brazing temperature is reached. This temperature has an enormous influence on the quality of the joint. To avoid heat-induced material damage, the required brazing temperature of 720 to 750 °C must be achieved quickly without overshooting and constantly maintained during the brazing process.

Only through the implementation of fast-responding pyrometer technology has it become possible to precisely control temperatures, thus preventing unnecessary heat penetration within the saw blade. In this way residual stress and the risk of crack formation in the segments can be avoided. The segments turn to graphite when heated to temperatures above 750°C. This chemical conversion creeps up little by little and will

depend on the heating duration and the degree by which the desired temperature was exceeded.

#### **Special pyrometer for induction brazing machines**

KELLER HCW GmbH's CellaTemp PS 28 was specially designed for those applications which place high demands on temperature measurement such as induction brazing and soldering operations. Because the CellaTemp PS 28 can measure temperatures between 300 °C and 1400 °C, this pyrometer covers the entire temperature range for soldering and brazing processes.

Since heating is only required at selected, localised points, it is all the more important that the instrument provide a high resolution and thus precise targeting. Due to the CellaTemp PS 28 high-precision optical system, targets with a diameter as small as 1.5



mm can be achieved.

#### *The pyrometer specifically detects the segment temperature*

The use of spot light illumination is essential in order to accurately aim the pyrometer at the target spot. The CellaTemp PS 28 has an integrated LED spot light based on most recent LED technology. Compared to a laser beam spot light, an LED has the advantage that it not only shows the precise

location of the target but the actual target spot size is defined as well. In addition, the an LED does not pose a health hazard and will radiate light continuously. The service life of an LED is several



times longer than that of a laser.

#### *CellaTemp PS 28 pyrometer with integrated LED spot light*

For precise temperature control of the heating process, a pyrometer must be able to instantly detect temperature changes. CellaTemp PS 28 offers a response time of 2 ms and is therefore ideally suited for immediate process control.

Because installation space at a brazing machine is often limited, the importance of compact instrument size is not to be underestimated. With a diameter of 30 mm and a length of 190 mm, the CellaTemp PS 28 –thanks to the screw thread mounting—can easily be installed in cramped locations.

#### **Summary**

In modern induction brazing and soldering facilities, temperature measurement using CellaTemp PS 28 combined with a programmed control system will ensure an efficient, highly repetitive and non-wearing production process with better product yield to satisfy today's high industry demands.