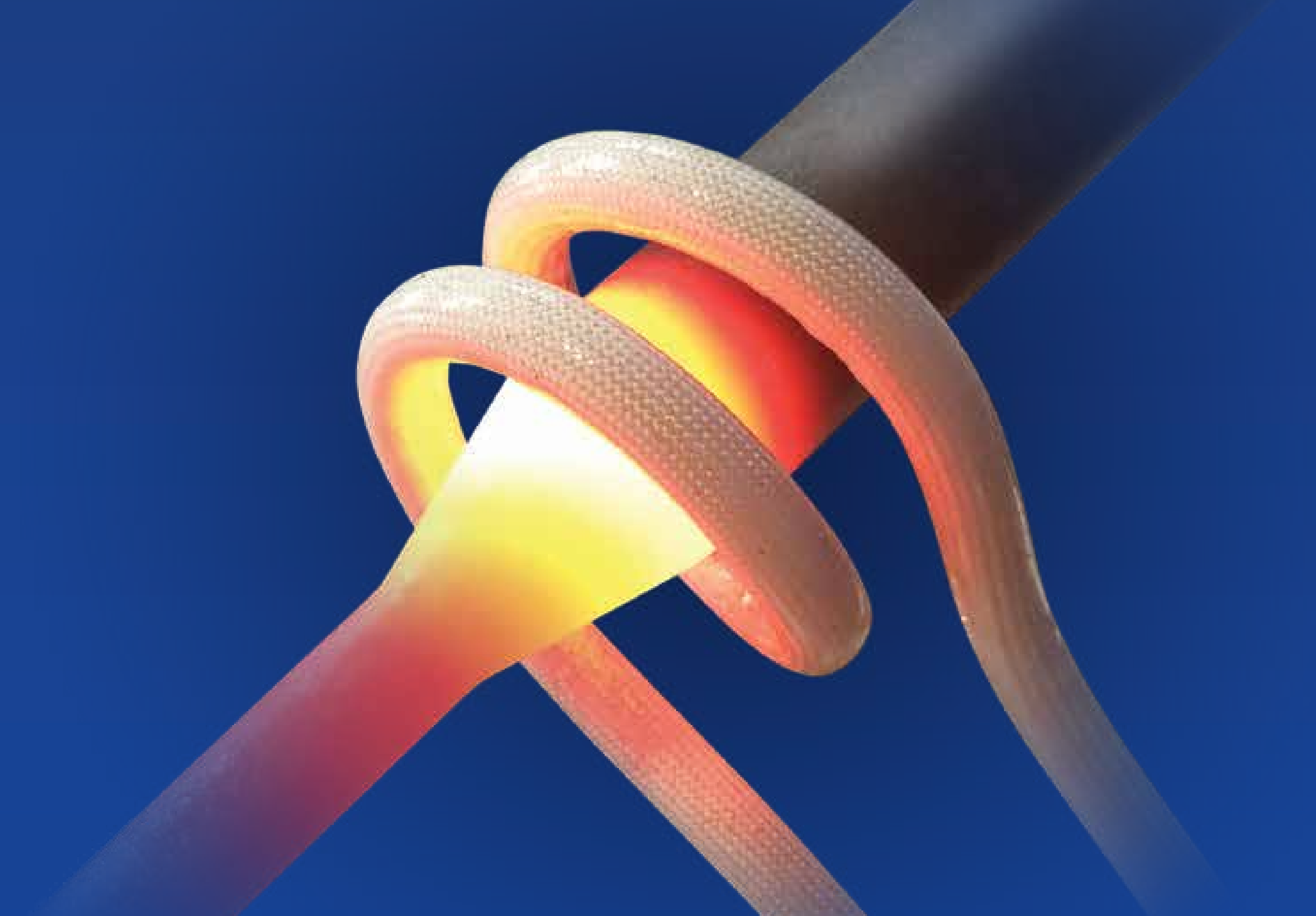
UltraFlex
POWER TECHNOLOGIES

Induction Heating Application Viewbook

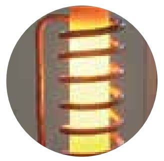


Induction heating application notes for industry

Induction Heating

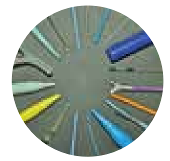
Induction heating is an ingenious and effective, non-contact process for electromagnetically heating electrically conductive materials such as metals and semiconductors. Heat is transferred to the material by a rapidly fluctuating magnetic field, created by running a high-frequency alternating current through an electromagnet specially designed for the application. Induction heating is not only fast and efficient, but also provides a high-tech, precise heating technique.

Some common Induction Heating Applications include:


Annealing


Bonding


Brazing

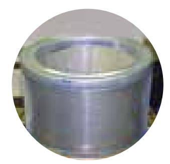

Carbide Tipping


Casting – Pressure

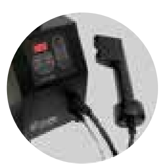

Casting Centrifugal


Catheter Tipping


Crystal Growing

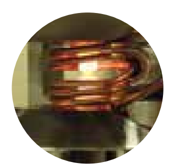

Curing / Coating


Forging

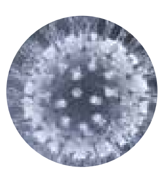

Golf Club Repair

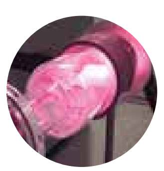

Hardening


Hot Forming

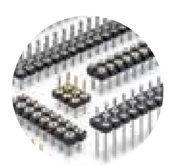

Materials Research and Testing

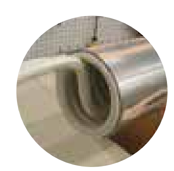

Melting of Metal


Nanoparticle Research

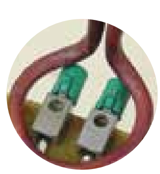

Optical Fiber

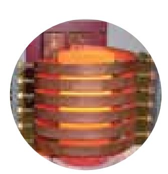

Plasma

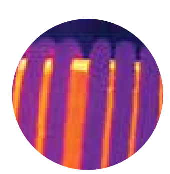

Plastic Reflow


Preheat and Postheat


Shrink Fitting


Soldering


Susceptor Heating


Wire Heating


Levitation with Induction

Content:

Induction Brazing Steel to Wolfram Carbide

The goal is to braze steel to wolfram carbide in 5 seconds using flux and braze alloy.

Materials
- Steel tool tail and wolfram carbide receiver
- Silver soldering paste (PN:R0113)
- Flux

Key Parameters
Temperature: Approximately 1440° F (780° C)

Equipment
Ultraheat UPT-SB3
1 MHz Power Supply

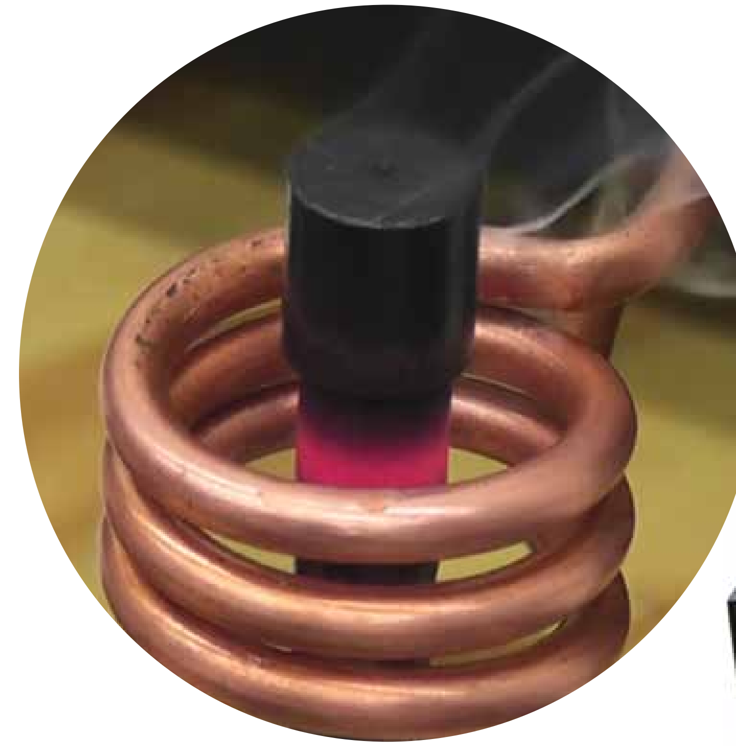
1. The assembly is positioned on refractory support.

2. Brazing paste and flux are placed on the assembly.

3. The coil is positioned .

4. The completed braze.

Induction Braze Carbide Cap to Steel Shaft



The objective of this application is to braze a cap to a steel shaft using induction.

Customer currently uses a torch process, but would like to change to induction to reduce scrap and rework and improve the quality of the braze.

Materials
- Carbon steel
- Magnetic carbide caps
- Alloy – EZ Flo 3 paste
- Test 1: Shaft Diameter: 0.5″ (12.7mm)
- Test 2: Shaft Diameter: 0.375″ (9.525mm)
- Test 3: Shaft Diameter: 0.312″ (7.925mm)

Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station

Key Parameters
Test 1
Temp: approximately 1450F (788° C)
Power: Pre-curie – 3.3 kW
Time: 11 seconds

Key Parameters
Test 2
Temp: approximately 1450F (788° C)
Power: Pre-curie – 1.8 kW
Time: 8 seconds

Key Parameters
Test 3
Temp: approximately 1450F (788° C)
Power: Pre-curie – 1.7 kW
Time: 7.5 seconds

Brazing Aluminum to Aluminum

The objective of the application test is brazing aluminum to aluminum in less than 15 seconds. We have aluminum tubing and an aluminum "receiver".

The brazing alloy is an alloy ring, and has a flow temperature of 1030°F (554°C).

Materials
- Aluminum tube: 0.167" OD, 0.108" ID (4.242mm OD, 2.743mm ID)
- Aluminum component: ID .1675", depth .288" (4.25mm, depth 7.315mm), chamfer at top area is 0.2375" (6.033mm) ID max
- Braze alloy in the form of two-turn alloy ring
- Flux

Key Parameters
Temperature: 1030°F (554°C)
Power: 2 kW
Time: 14 seconds

Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station

1. The aluminum component and aluminum tubing were assembled together with the alloy ring. Flux was added. The part was positioned in the induction coil.

2. Power was turned off after 14 seconds, and the process of brazing aluminum to aluminum was complete.

3. The aluminum tubing and aluminum component to be brazed, shown separately and as assembled.

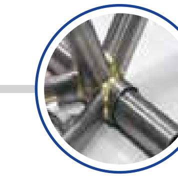
4. The completed aluminum to aluminum braze.

Brazing Carbide to Steel

Application test objective is brazing carbide to steel, and confirm heating time. Customer provided samples of carbide tips of various sizes and shapes to be brazed to steel shanks of various sizes and shapes. Confirm brazing feasibility and heating times using Ultraheat UPT-S5 5 kW for brazing carbide to steel.

Materials
- Magnetic steel shanks
- Carbide tips
- Alloy – EZ Flo 45 paste

Equipment
UltraHeat UPT-S5 Power Supply
HS-4 Heat Station



1

Test 1
Magnetic Steel Shank OD: 0.375″ (9.252mm)
Cone-Shaped Carbide Tip with taper from 0.5″ (12.7mm) OD to 0.062″ (1.575mm) at the peak

Key Parameters
Temperature: Approximately 1450°F (788°C)
Power: 1.3 kW
Time: 35 seconds

1. The 3 completed samples shown.

2

Test 2
Magnetic Steel Shank OD: 0.250″ (6.35mm)
Spherical Carbide Tip with 0.638″(16.20mm) diameter, and flat underside of 0.431″ (10.947mm)

Key Parameters
Temperature: Approximately 1450°F (788°C)
Power: 1.5 kW
Time: 21 seconds

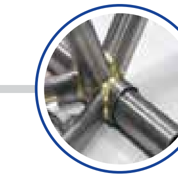
2. In-process picture of Test 2, with the spherical carbide heating using UPT-S5 5 kW Induction System.

3

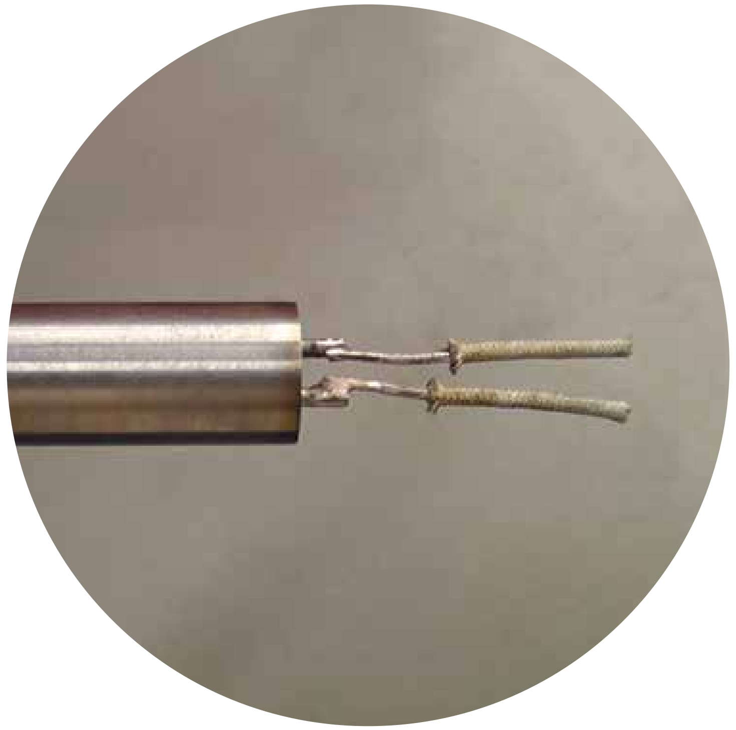
Test 3
Magnetic Steel Shank OD: 0.180″ (4.572mm)
Bullet-Shaped Tip with Major OD 0.264″ (6.706mm)

Key Parameters
Temperature: Approximately 1450°F (788°C)
Power: 0.6 kW
Time: 13 seconds

3. In-process picture of Test 3, with the bullet-shaped carbide heating using UPT-S5 5 kW Induction System.



Induction Brazing Alloy to Wire



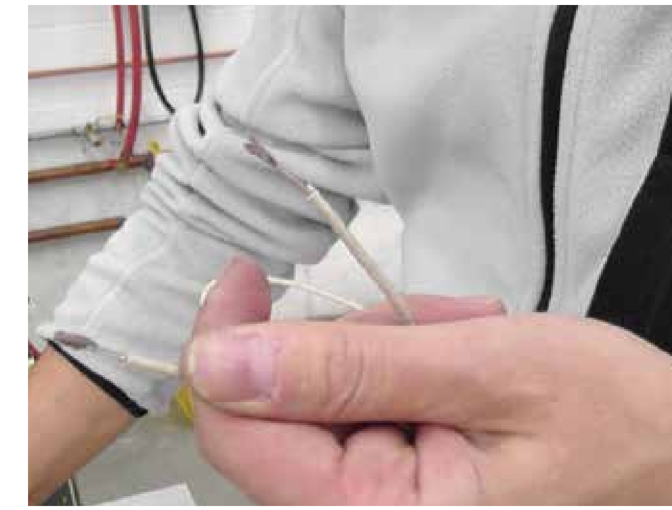
The goal of the test application is induction brazing alloy to wire, with the wire as short as possible.

Materials
• Brazing paste (Easy-Flo 45)

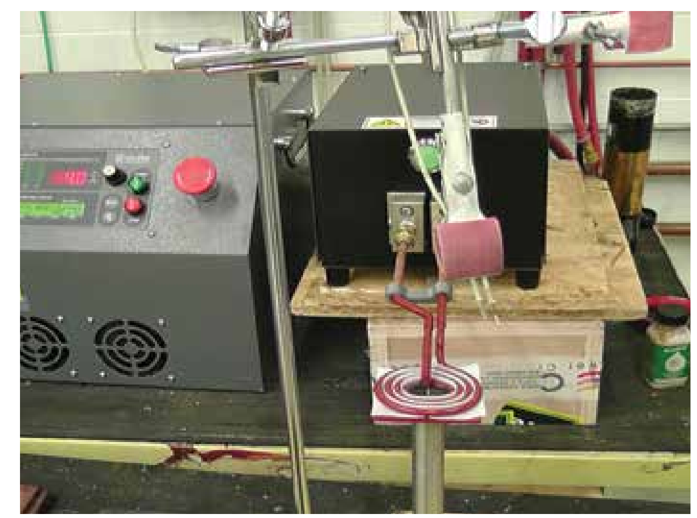
Key Parameters
• Power: 2.4 kW
• Time: 4 Seconds

Equipment
UPT-S5, Ultraheat 5 kW Power Supply
HS-4 Heat Station
Plate concentrated coil

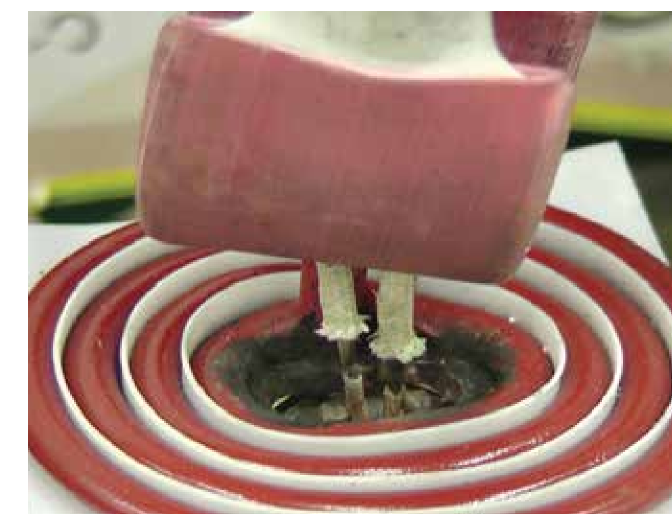
1. Brazing flux is applied



2. Placing the brazing flux on the alloy

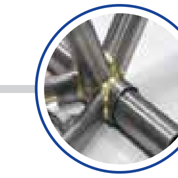


3. The wire is positioned inside the coil

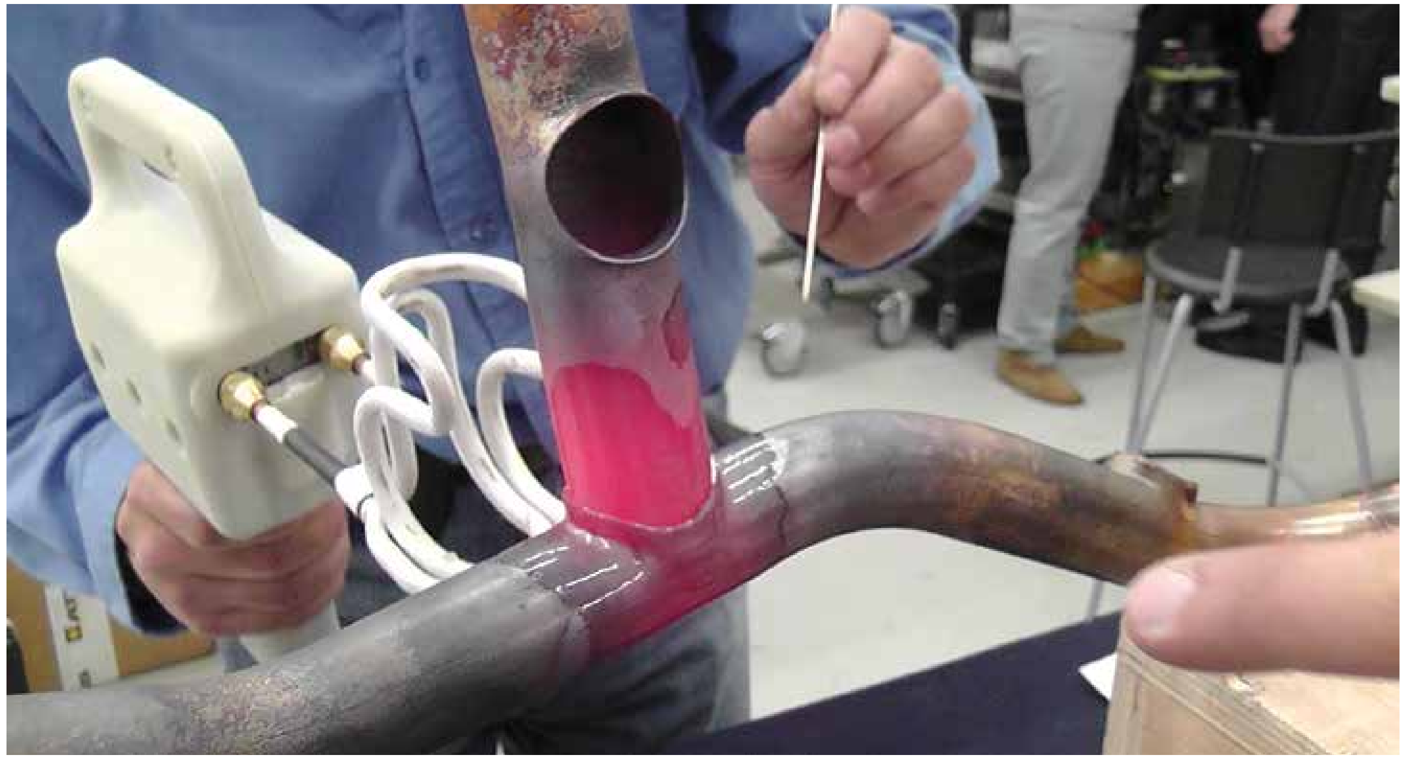


4. A closer view of the positioning inside the coil

5. A finished piece



Brazing with Ultraflex UBraze Handheld Brazing System



The customer needs to braze copper tubing to copper tubing using brazing alloy and flux. The copper tubing is in a variety of shapes, and is not always easily positioned using a traditional heat station. Therefore, the customer would like to utilize the Ultraflex UBraze Handheld Brazing System. There are no time restrictions.

Materials
- Copper tubing
- T Coil, to allow ideal positioning with copper tubing joints
- Brazing rod
- Flux

Key Parameters
Temperature: about 1400°F (760°C)
Power: 8.43 kW
Time: No time limit was established.
The braze took about 3 minutes from start to finish.

Equipment
UPT-S5, Ultraheat 5 kW Power Supply
HS-4 Heat Station
Plate concentrated coil

1. UBraze Handheld Brazing System with T Coil

2. UBraze is positioned at the joint.

3. UBraze heats the joint.

4. UBraze heats the joint.

5. The UBraze is re-positioned on the other side of the joint, to heat the area previously left open by the T Coil.

Induction Brazing Steel Tubing to Copper Tubing

The goal is to braze steel tube to copper tube in 60 seconds using flux and braze alloy.

Materials
- Steel tube and copper receiver
- Braze alloy (CDA 681)
- B-1 Flux

Temperature:
Approximately 1750° F (954° C)

Equipment
Ultraheat UPT-W15 Power Supply
HS-8 Heat Station
Three turns dual diameter coil

Brazing a Heat Exchanger

The customer's application is brazing a heat exchanger. There are "U" returns that are brazed to the receiving tubes on the heat exchanger. These returns are used to flow the water through the heat exchanger, and keep the unit cooled. Brazing tests were conducted with flux and without flux at the customer's request.
The current process is done with a torch.

Materials
- Brazing preform
- Brazing flux (Test 1 only)

Key Parameters
Temperature: Approximately 1400-1450°F (760-788°C)
Power: 2.35 kW
Time: 35 seconds for the first part. Slightly less time for subsequent parts, as heat is retained.

Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station

1. Flux is applied to the "U"-shaped returns

2. "U"-shaped returns are assembled to the receiving tubes.

3. We braze each u-shaped return. Brazing takes approximately 35 seconds per return.

Automated Induction Brazing of Copper Pipes in Refrigerator Assembly for In-Place Brazing

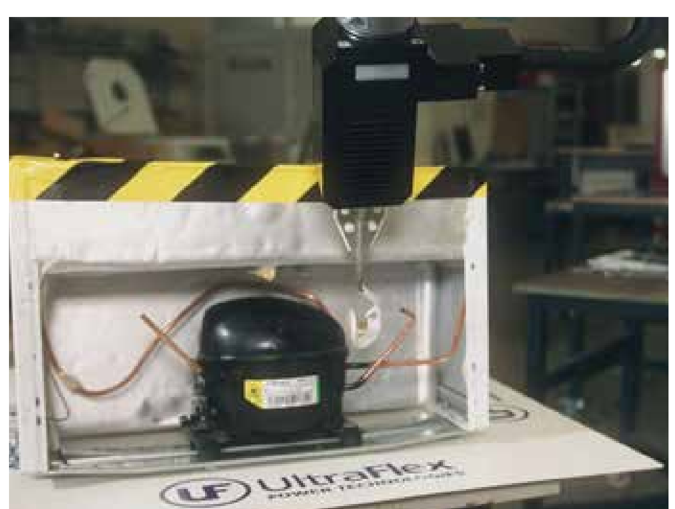
Objective
The objective is to automate the brazing of multiple joints on refrigerator pipes using induction heating.

Equipment
Dragon 15 – Robotic Brazing System

Materials
- Copper pipes size 0.236” x 0.0295” (6 x 0.75 mm)
- Brazing rings – 0.0393” (1 mm) (CuP7)

Process:
The Dragon15 brazes multiple joints located in predefined positions in the assembly. Brazing alloy rings are placed on the joints prior to the brazing process.
The robotic system is programmed to move to each joint and apply certain amount of power for a the pre-programmed amount of time, to ensure repeatable and reliable brazing process.

The system can be integrated to accommodate different production line speeds and multiple assemblies.



Automated Brazing of Copper Pipes with Automatic Feeding of Brazing Wire

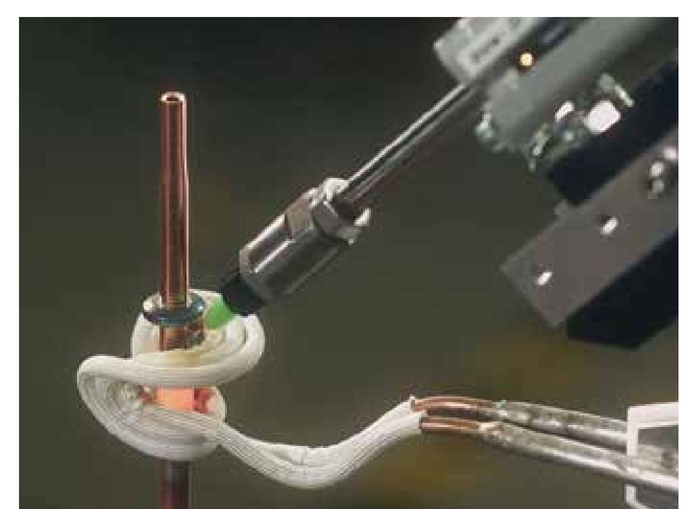
Objective
Induction brazing of copper pipes with automatically fed wire. Universal robots-UR5 is integrated to work with a 15 kW induction system and a wire feeder.

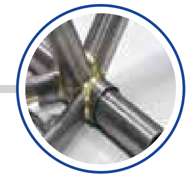
Equipment
Dragon 15 – Robotic Brazing System with Wire Feeder

Materials
- Copper pipe 0.236” x 0.0295” (6 mm x 0.75 mm)
- Brazing wire – 0.031” (0.8 mm) (silver brazing alloy: L-Ag 56 SN (DIN 8513) BAg-7 (AWS A5.8) ~Ag 156 (EN ISO 17672).

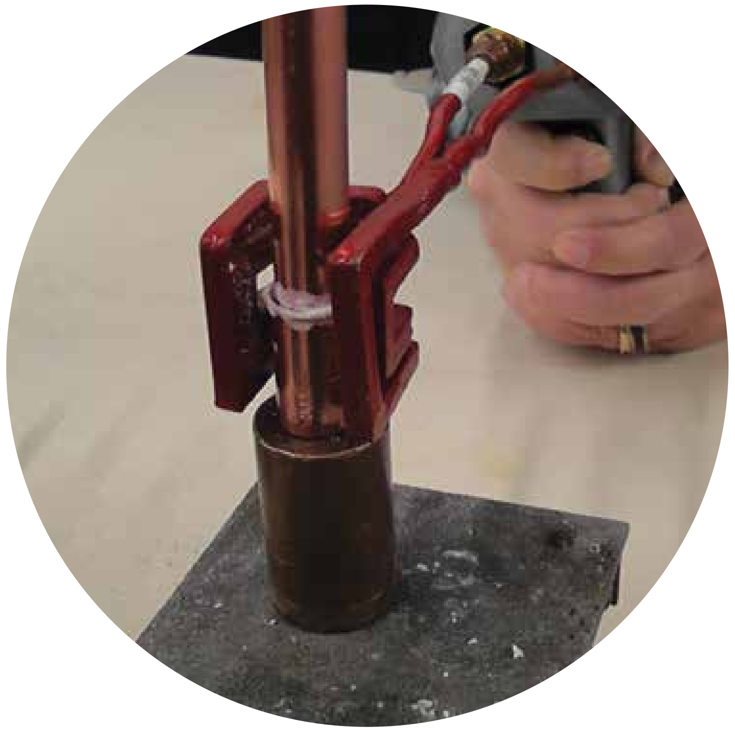
The Dragon15 Robot controls the induction system via its PLC interface. Special RoboBraze gripper is used for attaching the induction coil to the robot’s hand.

Process:
The Dragon15 is programmed to reach predefined joint positions. The robot controls the induction system and the wire feeder via PLC interface. The wire feeder is programmed to start feeding the wire when the brazing temperature is reached.





Induction Brazing Using Handheld Brazing System

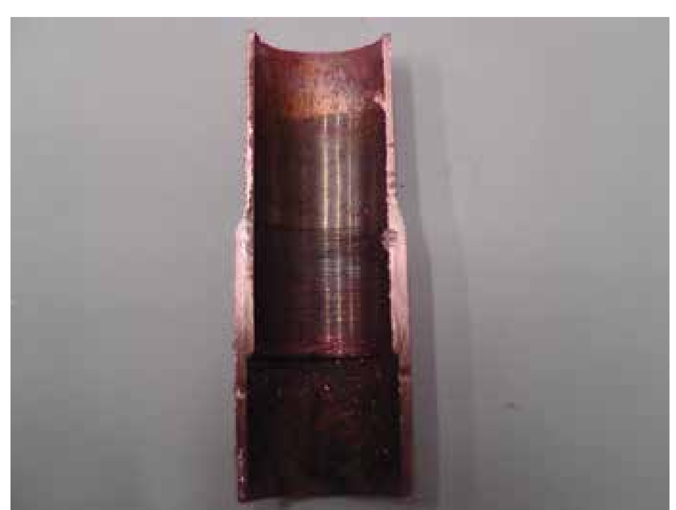


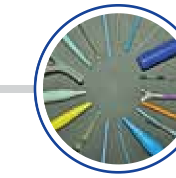
Objective
Induction brazing copper of copper: ½" copper tubing and copper fitting with brazing alloy and flux using the UBraze HandHeld Brazing System.

Equipment
UltraFlex UPT-W10 Power Supply
UBraze Handheld Brazing System

Materials
- Copper fitting
- Copper tubing
- Silver brazing alloy (pre-formed)
- Flux

Process:
The UBraze Handheld Brazing System allows the operator to move the coil to the braze joint and heat the part. This is similar to a torch process but with faster heat times, higher and without the risks associated with open flame brazing.





Brazing Carbide Tips to Steel Impeller

The objective of this application test is brazing carbide tips to a steep Impeller. Use induction heating to first debraze used carbide tips from the steel impeller, and then rebraze new replacement carbide tips.
Customer is considering bringing the job in house in an effort to improve turn-around time and minimize downtime.

Materials
- Steel Impeller
- Carbide 0.085" thick x 0.877" wide (2.159 mm x 22.27 mm)
- EZ Flo 3 braze paste

Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station

Key Parameters
Test 1 (Used Carbide Tip Removal)
Temperature: Approximately 1450°F (788°C)
Power: 4 kW
Time: 8 seconds

Key Parameters
Test 2 (Replace Braze Carbide Tip)
Temperature: Approximately 1450°F (788°C)
Power: 2.93 kW
Time: 14 seconds

1. Photo showing the area following carbide removal

2. Position of the part for the heat-cycle to remove the used carbide – heat time test 8 seconds

3. Resulting re-braze repair

Heating to Curing Temperature using Induction

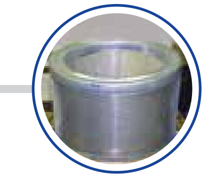
In this application test, we are heating to curing temperature using induction, to attach a speaker diaphragm to a speaker basket. The adhesive will be applied to the speaker basket, and the speaker diaphragm placed immediately above. The adhesive has an activation temperature of 134° F, or 57° C. The customer wants to use induction for heating the speaker basket to the curing temperature. This will activate the adhesive, and create the bond to the rubber speaker diaphragm.

This application test will confirm that the speaker basket will heat to the curing activation temperature of 134° F (57° C) within 2-3 seconds.

Materials
- Two-turn induction coil

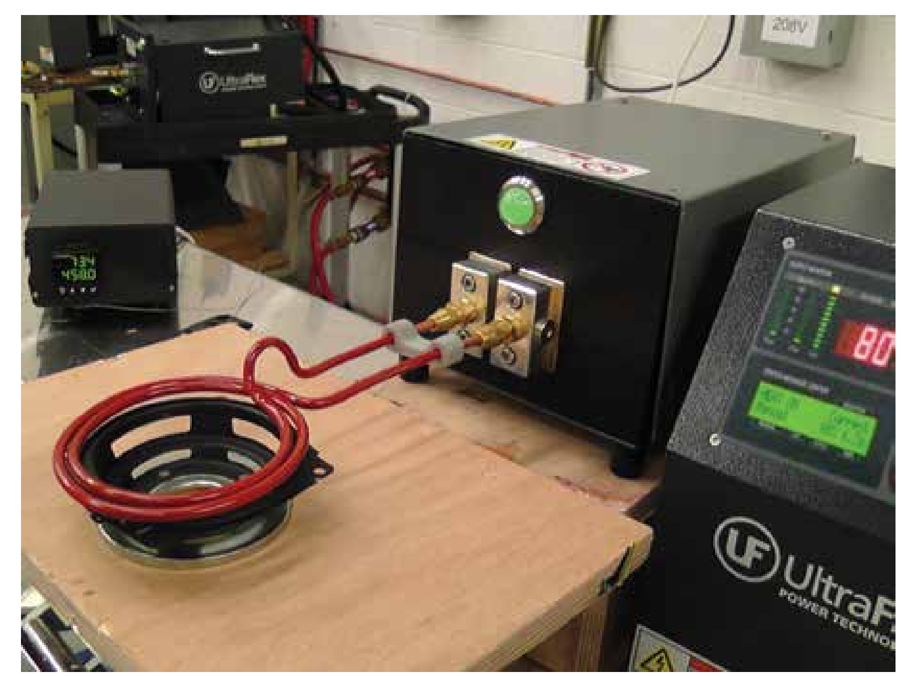
Key Parameters
- Temperature: Just above 134° F (57° C)
- Power: 0.5 kW
- Time: 2 seconds

Equipment
Ultraheat UPT-S2 Power Supply
HS-4 Heat Station

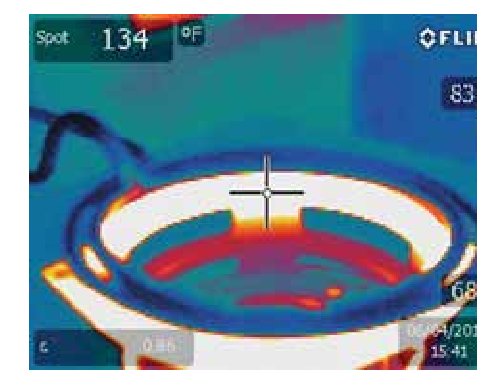


1. Speaker Diaphragm

2. Setup of Induction System with Speaker Basket.



3. Setup of Induction System with Speaker Basket.



4. Infrared Picture

Levitation Melting 2g of Aluminum

Levitate and melt 2g of aluminum using a specially-designed levitation coil.

Traditional melting applications impart impurities into the melted material. Levitation melting can be used for a well-controlled high-purity melt for precise materials research.

Materials

- 2g aluminum metal
- Test tube

Key Parameters

Power: 1.72 kW

Equipment

Ultraheat UPT-S2 Power Supply
HS-4 Heat Station
UltraFlex Levitation Coil

1. UPT S-2 power supply, HS-4 heat station, and levitating sample at the beginning of operation.

2. The aluminum sample levitated in the coil by induction.

3. The melted aluminum at the end of the process, stably contained by levitation.

Hot Forming Steel Cable

This hot forming steel cable application is a great fit for induction heat. For cables, there are additional factors to consider when heating with induction. If the cable was manufactured very tightly with large strands of wire, the cable may behave similar to a solid cylinder when heated, which is very efficient. However, a loosely assembled cable with small wires, will behave more like many small parts to heat. For smaller parts, higher frequency is more effective in induction heating. In this case, the customer has a steel cable with a ferrule attached. After heating the end of the cable to approximately 2000°F (1093°C), they deform it with a hammer, which then keeps the ferrule in place.

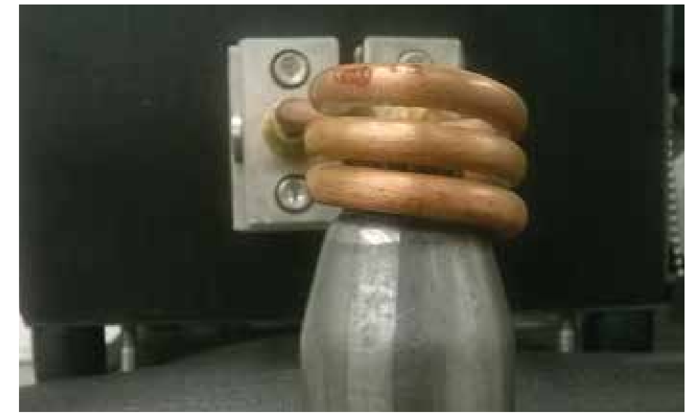
The customer's goal is to reduce the heating time for this process, which is currently heated with a torch. The goal of this test is to heat the end of the steel cable to 2000°F (1093°C) in a total cycle time of 90 seconds or less.

In this application we are heating above curie for the steel. Curie is the temperature where the metal's properties change from magnetic to non-magnetic – in this case, 1390°F or 770°C. Since magnetic metals heat using induction more readily than non-magnetic metals, heating past the curie temperature affects how efficiently we can heat the metal. Post curie therefore requires more power to heat than pre curie.

Materials
- Magnetic steel wire cable 0.5625" (14.288mm)
- Magnetic steel ferrule (tapered, 1.08" (27.432mm) at widest point)

Equipment – Test 1
Ultraheat UPT-S2 & HS-4
Power: 2 kW

Equipment – Test 2
Ultraheat UPT-S5 & HS-4
Power: 5 kW



1. The steel cable with attached ferrule is positioned in the induction coil. No part of the load is to touch the coil.

2. Top view of the steel cable positioned in the coil.

3. The steel cable heats in the induction coil.

4. The end of a steel cable is heated to 2000°F (1093°C).

Key Parameters of Test 1:
Power:
Pre Curie – 0.92kW
Post Curie – 1.92kW

Time: 227 seconds to 2000°F (1093°C)

Key Parameters of Test 2:
Power:
Pre Curie – 2.41kW
Post Curie – 4.48kW

Time: 70 seconds to 2000°F (1093°C)

Melting Platinum using UltraMelt 5P

The purpose of the application test was melting platinum, and to determine what quantities will melt effectively in the UltraMelt 5P.
Due to its properties and high melting temperature, platinum is a challenging metal to melt.
The UltraMelt 5P is the ideal equipment for this task.

Materials
- Scrap platinum
- Crucible for melting
- A lid for the crucible
- Tongs
- Pipettes

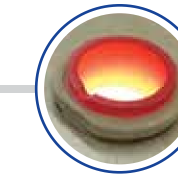
Key Parameters of Test 1:
Melting Platinum – 250g of Scrap
Temperature: Over 3200°F (1768°C)
Power: 3.9 kW – 4.8 kW (power varied during the melting process)
Time: 4 minutes, 35 seconds

Key Parameters of Test 2:
Melting Platinum – 250g of solid
Temperature: Over 3200°F (1768°C)
Power: 3.1 kW – 4 kW (power varied during the melting process)
Time: 4 minutes, 10 seconds

Equipment
UltraMelt 5P

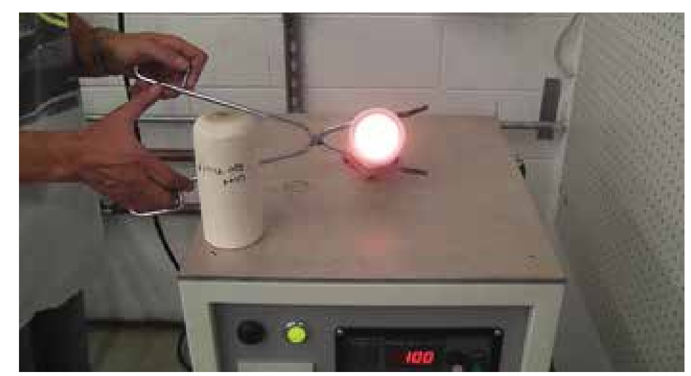
1. During the test, the engineer taps periodically on the crucible to help in the heating process. The engineer is wearing welding goggles, due to the brightness of the molten platinum.

2.Here we see the second crucible used as a lid for the primary crucible.



3.During test 2 a pipette was lowered into the molten platinum to take a sample.

4. When taking the sample, there was a brief flare.



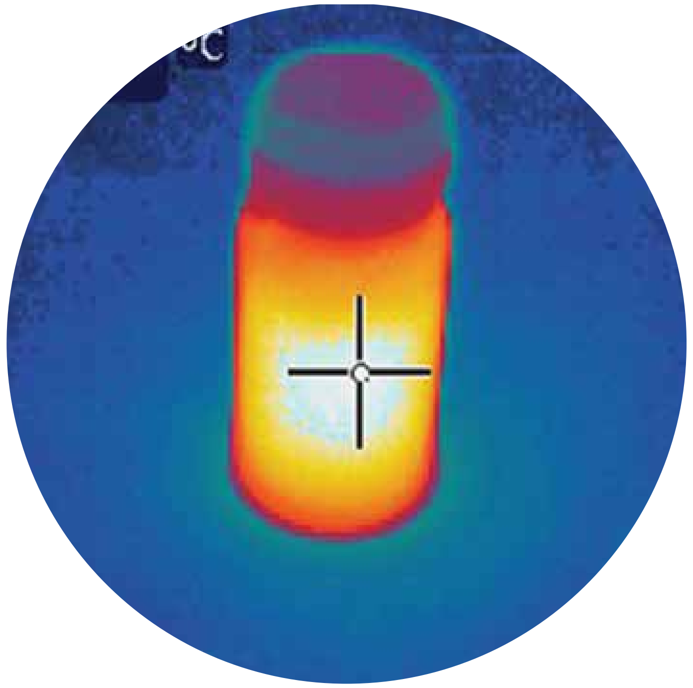
5. A view of the still hot platinum in the bottom of the crucible.

6. After cooling time, the platinum releases from the crucible.

7. The final melted piece of platinum after cooling.

8. The pipette with the cooled sample.

Heat Test for Magnetic Hyperthermia



The customer is doing nanoparticle research related to magnetic hyperthermia. A sample vial with solution and magnetic nanoparticles were provided. The objective of the test is to confirm that the system is capable of heating the solution to 140°F (60°C)

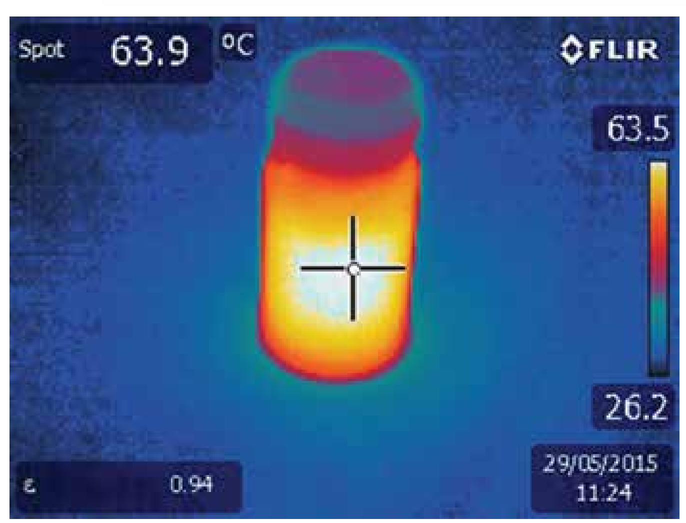
Materials

- Glass vial provided by customer, with proprietary solution and nanoparticles.
- Coil, designed and manufactured by Ultraflex Power Technologies, to optimize magnetic field strength during nanoparticle heating.

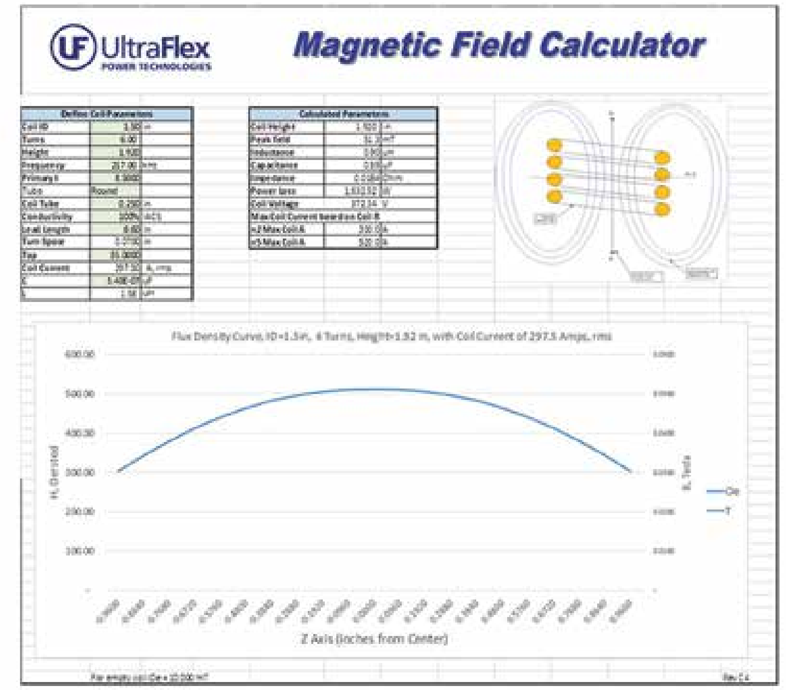
Key Parameters
Temperature: About 140°F (60°C)
Power: 1.59 kW
Time: About 90 seconds

Equipment
Ultraheat UPT-S2 Power Supply
HS-4 Heat Station

1. Vial has been placed into the coil. An Infrared Camera is positioned above to measure the temperature.



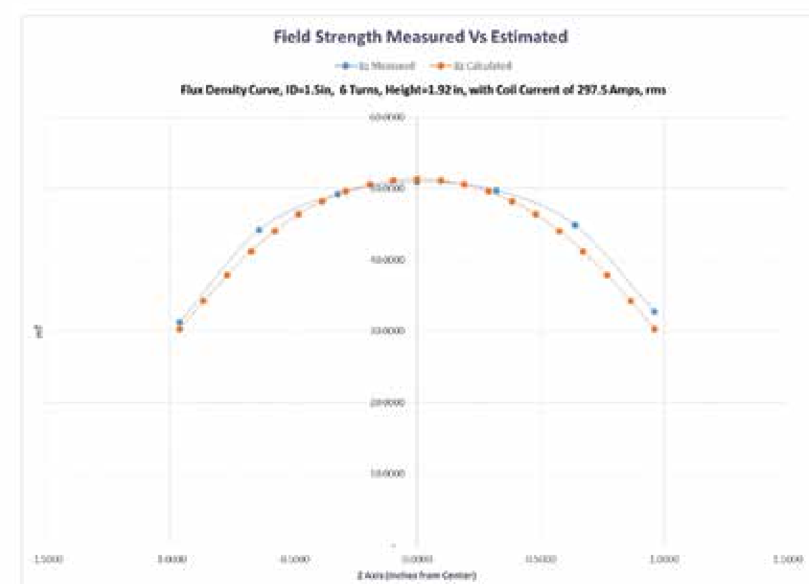
2. Infrared photo of the heated vial.



3. Verification of Magnetic Field for Nanoparticle Heating

The key parameter for heating nanoparticles is the magnetic field strength of the induction coil. Ultraflex has proprietary tools to calculate the field strength and other key parameters for custom coils for nanoparticle heating applications.

We have verified the performance of these tools against real world tests to ensure their accuracy.



4. For this application we had a peak field of approximately 50mt with the peak field at the center of the coil.

This also corresponds to the heating profile of the solution as shown in the infrared image.

Below is the comparison to our calculated field and the actual measured field strength.

Induction Heating Stainless Steel Tube

To generate plasma, we apply an electrical field to a gas, with the goal of removing electrons from their nuclei. These free-flowing electrons give the plasma key properties, including its electrical conductivity, a magnetic field, and sensitivity to external electromagnetic fields.

In this application test, the customer provided sample parts to be heated. Ultraflex demonstrated the ability of the UPT-S5 induction system to heat the stainless steel tube to 1700°F (927°C) within one minute.
This successful application test for induction heating a stainless steel tube for plasma research, validated the customer's use of the system for his testing.

Materials
• Stainless steel tube 2" (50.8mm) nominal OD 0.047" (1.194mm) wall thickness

Key Parameters
Temperature: 1700°F (927°C)
Power: 4.2 kW
Time: 60 seconds

1. Stainless Steel Tube used for Plasma Research testing

2. Stainless Steel tube heated with UPT-S5

Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station

Plasma Research

Induction Heating Mesh Tube

In this application test, the customer provided sample parts to be induction heated.

Ultraflex demonstrated the ability of the UPT-S5 induction system to heat the stainless steel mesh tube to 1700°F (927°C) within one minute.

The test validated the use of this system for the customer.

Materials
• Stainless steel mesh tube 2.2" (55.88mm) OD, 0.020" (0.508mm) wall thickness

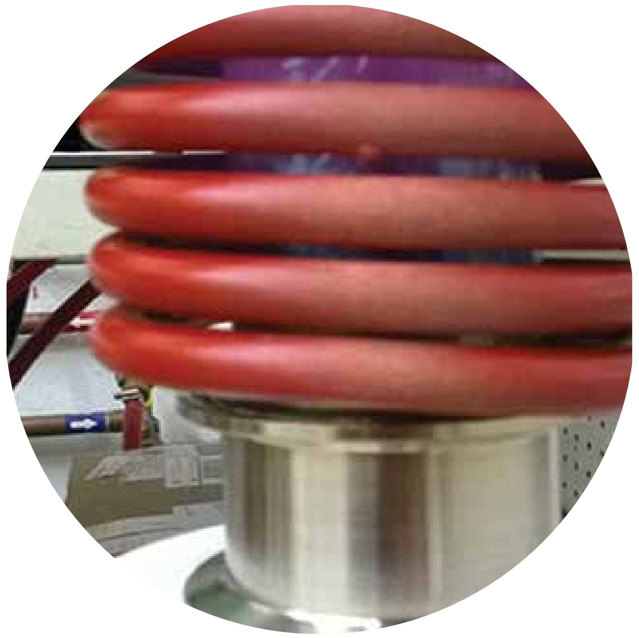
Key Parameters
Temperature: 1700°F (927°C)
Power: 2.8 kW
Time: 39 seconds

1. Mesh Tube used for testing

2. Mesh Tube tested with UPT-S5 Induction Heating System for Plasma Research.

Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station

Induction Heating Stainless Steel Cup



In this application test, the customer provided sample parts to be induction heated.

Ultraflex needed to demonstrate the feasibility of the UPT-S5 system for induction heating stainless steel cup for plasma research by heating the cup to 1350°F – 1400°F (732°C - 760°C) within three minutes.

Materials
• Stainless steel cup – 1.854" (47.09mm)OD, ID – .570" (14.478mm)

Key Parameters:
Temperature: 1350 – 1400°F (737-760°C)
Power: 2 kW
Time: 180 seconds

1. Mesh Tube used for testing

2. Mesh Tube tested with UPT-S5 Induction Heating System for Plasma Research.

Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station

Induction Heating Silicon Carbide Cylinder

In this application test, the customer provided sample parts to be heated with induction.

Ultraflex demonstrated the ability of the UPT-SB High Frequency Induction System to heat the silicon carbide cylinder to 2700-2800°F (1480-1540°C) within three minutes.

This demonstrated the feasibility of the system for induction heating silicon carbide for plasma research.

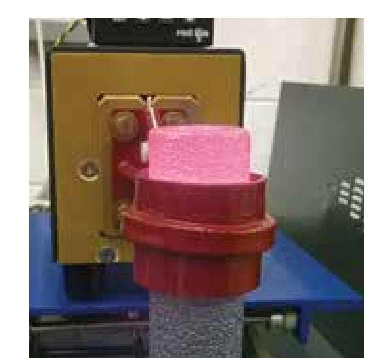
Materials
• Silicon carbide cylinder,
with 1.22" (30.988mm) OD and 0.5" (12.7mm) ID

Key Parameters:
Temperature: 2700-2800°F (1480-1540°C)
Power: 1 kW
Time: 180 seconds

Equipment
Ultraheat UPT-SB Megahertz System

1. Silicon Carbide Cylinder.

2. Silicon Carbide Cylinder heated to 2700-28000F with 1 MHz induction.



3. Silicon Carbide Cylinder heated to 2700-28000F with 1 MHz induction

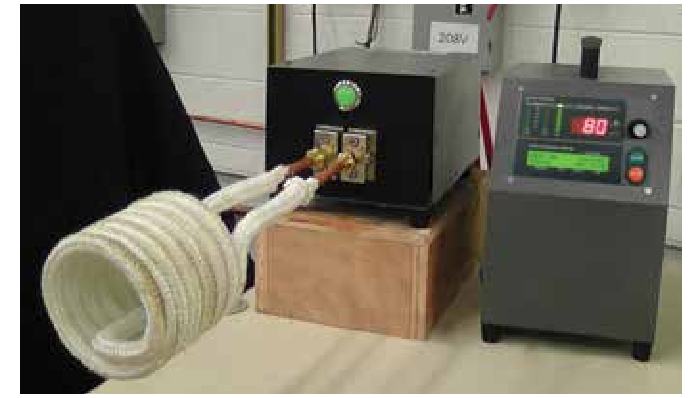
Induction Preheat Steel Tubing

Using a 7-turn induction ID coil, heat a 4.3”(10.92cm) ID steel tube to 700°F (371°C) in under one minute using the UPT-S2 and HS-4 Heat Station.

Equipment
Ultraheat UPT-S2 Power Supply
HS-4 Heat Station

Materials
• 4.5” (11.43cm) steel tube
• 7-turn induction coil, designed and manufactured by UltraFlex Power Technologies for this specific application.
• Tempilaq 650, 700, 750, used to confirm when desired temperature has been met.

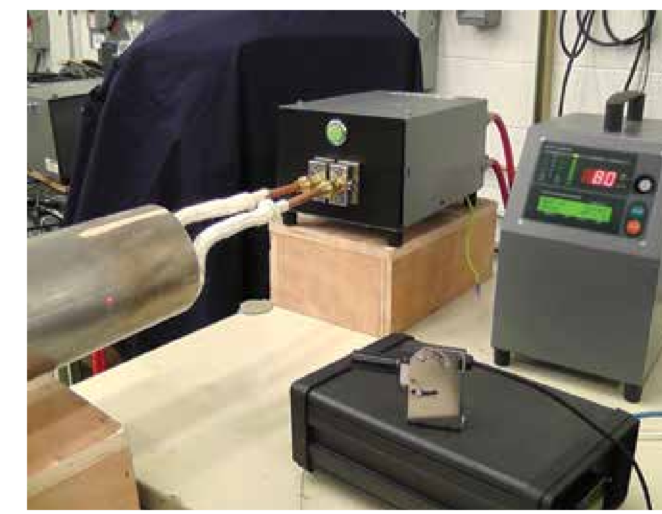
Key Parameters
Temperature: 700°F (371°C)



1. UPT-S2, HS-4 and Induction Coil are set up

2. Induction Coil is placed inside Steel Tube

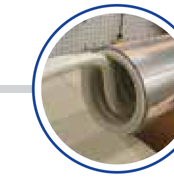
3. Induction preheat steel tubing



4. Infrared Temperature Monitor is used to check temperature

5. Tempilaq Indicating Liquid

6. Tempilaq and Infraret temperature monitor are used to verify when we have reached 700F.



Preheat for Threading

The customer preheats a variety of parts so they can then be threaded. The objective of this test is to preheat each part to 600°F (316°C) in under 30 seconds.

Materials
Sample parts were provided by the customer. These included:

- Part 1 composed of magnetic steel with 0.375” (0.95cm) OD
- Part 2 composed of magnetic steel with 0.5” (1.27cm) OD
- Part 3 composed of magnetic steel with 0.875” (2.22cm) OD
- Part 4 composed of magnetic steel with 1.5” (3.81cm) OD

Two coils were used. Coil 1 for heating part 4 with the 1.5” (3.18cm) OD. All other parts were heated with Coil 2.

Key Parameters

Temperature: About 600°F (316°C)

Power:
- Part 1:1.68 kW
- Part 2: 2.6 kW
- Part 3: 4.74 kW
- Part 4: 3.79 Kw

Time: Less than 30 seconds

Equipment
UltraFlex UPT-S5 Power Supply
HS-4 Heat Station

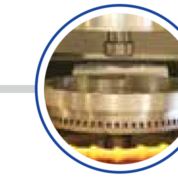
1. UPT-S2, HS-4 and Induction Coil are set up

2. Induction Coil is placed inside Steel Tube

3. Induction Coil is placed inside Steel Tube

4. Tempilaq Indicating Liquid

5. Tempilaq and Infraret temperature monitor are used to verify when we have reached 700F.



Shrink Fit Part Removal

This is a shrink fit part removal application. The customer's current process uses a press to push the inserted part out. However, this requires significant force and time.

By applying heat, the housing can expand just enough to allow for the easy removal of the inserted part with minimal force.

The customer's time requirement is to complete the shrink fit part removal within 7 minutes.

Materials
• Aluminum pump housing part OD 2.885” (73.279mm), wall 0.021”(0.533mm)

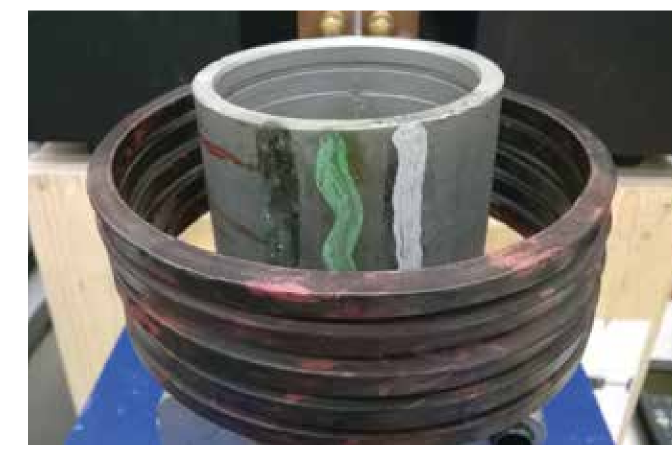
Key Parameters
Temperature: Approximately 400°F (204°C)
Power: 2.9 kW
Time: 100 seconds

Equipment
UltraFlex UPT-S5 Power Supply
HS-4 Heat Station

1. Part in the coil

2. Part in the coil

3. Part is removed with minimal force.

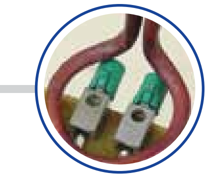


4. We see from the tempilaq paint stripes that the assembly, which heated for 100 seconds, peaked over 350F and approached 400F.

This shrink fit application was further reviewed to determine if a lower power induction system could be used. In this case, the customer's requirement was 7 minutes, and we achieved the part removal in 100 seconds. Could a lower power system remove the part at a lower cost?

A lower power system would be acceptable if our goal is part insertion. For Shrink Fit – Part Insertion, a slower heating rate would still result in a successful process. However, with Shrink Fit – Part Removal, it is important to heat rapidly.

A slower heat rate would result in the inserted part heating, and expanding. The inserted part potentially would remain “stuck”. By heating rapidly, we avoid this issue. The customer in this case has decided to both use a system for part insertion AND part removal. A UPT-S2 2 kW system is fine for the Shrink Fit – Part Insertion; and the UPT-S5 5 kW system will be used for the Shrink Fit – Part Removal.



Solder End Connectors to a Printed Circuit Board

Use induction to simultaneously solder two end connectors to a printed circuit board within 120 seconds. The process must ensure a good solder joint for the component feet and the center pin conductor, which is shielded by the conductor body.

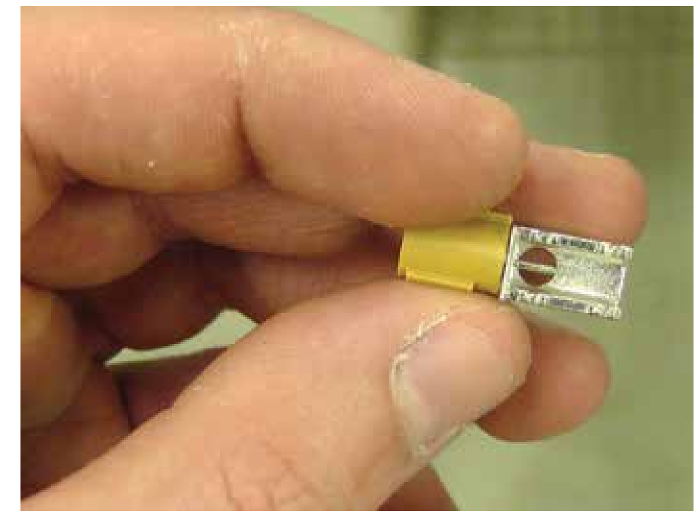
The customer requirements allow for the soldering of the feet and the center pin in two separate steps; however, only a single coil can be used.

The current process using a traditional soldering iron currently takes the customer 25-30 minutes.

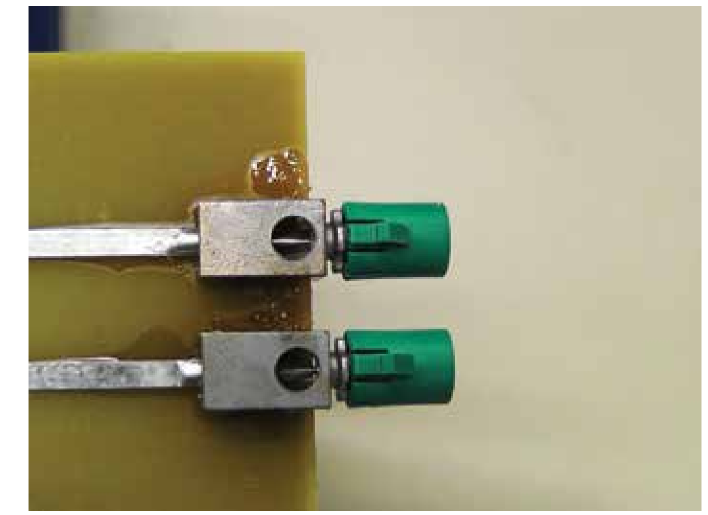
Materials
• Single turn induction coil, with approximate 1.2 inch (30.48mm) diameter, made from 3/16" (4.76mm) diameter tubing connected to 3/16" (4.76mm) flare fittings.
• Solder alloy Sn 96.3/Ag3.7

Key Parameters
Temperature: Just above 450 °F (232°C)

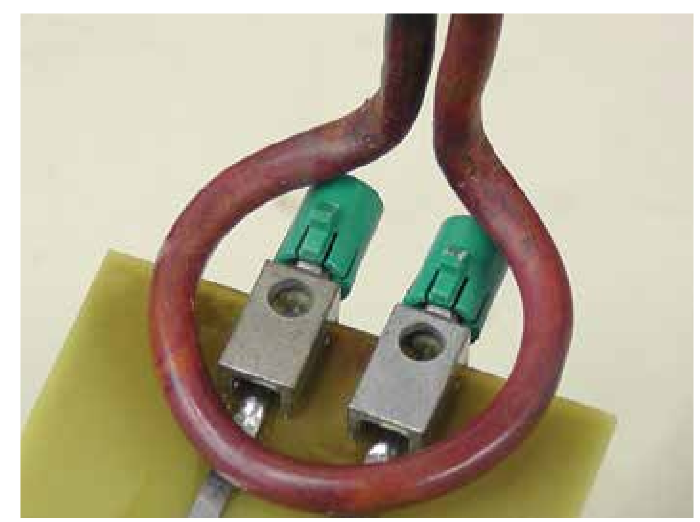
Equipment
UltraFlex UPT-S2 Power Supply
HS-4 Heat Station



1. A close up view of the component to be soldered

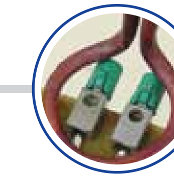


2. Setup of component on PCB, with solder paste applied.



3 . Induction Coil is placed above the components.

4. The solder joints.



Induction Soldering of PCBs with Soldering Paste

The customer uses a manual solder process. The current time to join 7 PCB's is 1 minute 45 seconds. It does not include the time to apply the solder paste and place the jumper across the PCBs in the paste.

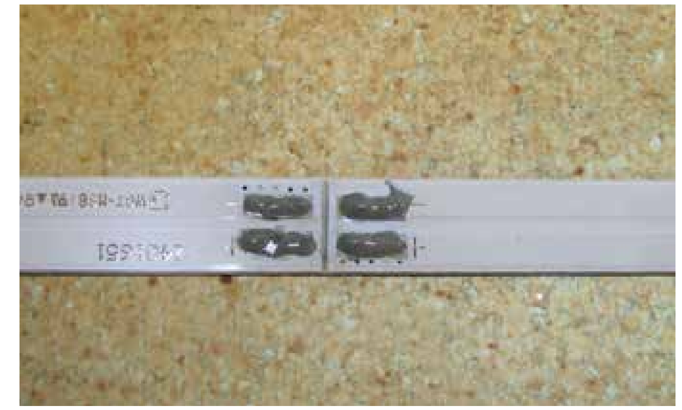
Our goal is to use induction soldering to reduce the cycle time while producing a high quality solder joint.

Materials
- Soldering wire
- Soldering paste

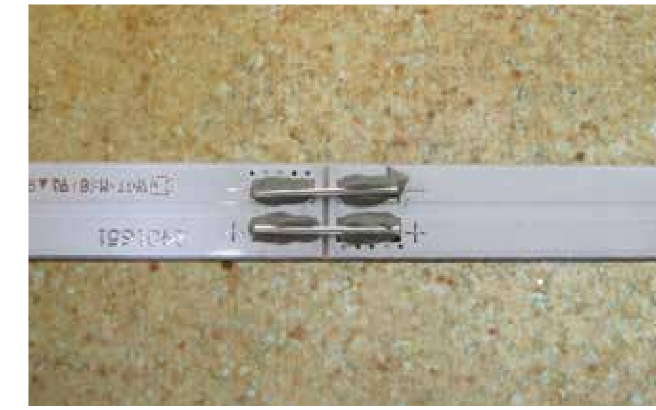
Application of the solder paste with a stencil is recommended. This will provide improved process control, better repeatability, and avoid any residues.

Key Parameters
Temperature: 572° F (300°C)
Power: 3 kW
Time: 14 sec for joining 7 boards

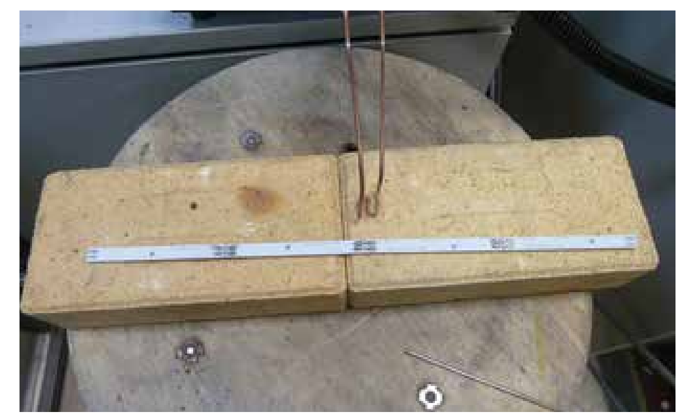
Equipment
Ultraheat UPT-S5 Power Supply
HS-4 Heat Station
Two-turn custom designed coil



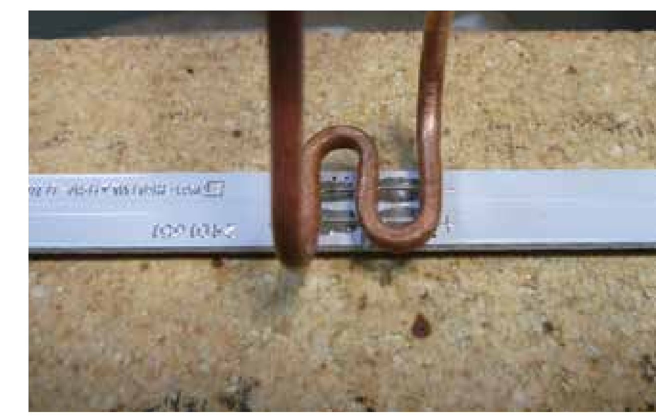
1. Solder paste is applied to the pads.



2. Jumpers are placed in the solder paste across the pads of the adjacent PCBs.

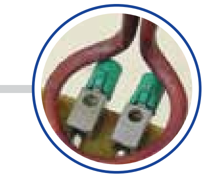


3. The boards are positioned under the induction coil.



4. A close up view of the boards positioned under the induction coil.

5. Soldered jumpers



Soldering Copper Pins onto a PCB

For this application, the customer needs to define a new process for manufacturing a small PCB assembly, due to a material change for one of the components.

The customer needs to attach copper pins to a PCB (this is a small potentiometer assembly). During the assembly process, the heated pins will conduct heat into the solder paste, and cause the solder paste to flow. For this test, the solder paste is not important. Our goal is to confirm that the copper pins will meet the target temperature of approximately 500° F (260° C), and we can meet the customer's target cycle time of 1 second per PCB.

Materials
• Printed circuit board (PCB)– substrate 0.217" x 0.0197" x 0.025" (5.51mm x 0.5mm x 0.635mm) thick plated copper

• Copper Pins, 0.016" (0.406mm) diameter, 0.475" (12.065mm) long, 3 pins per PCB (mechanically connected prior to soldering)

Key Parameters
Power: 2.4 kW
Time: 12 sub assembly boards in 3.5 seconds
Temperature: Tested temperature 500° F (260° C)

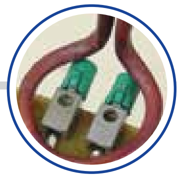
Equipment
SB-3/1000 Power Supply, operating up to 1 MHz
HSB-3 Heat Station

1. The small PCB sub-assemblies are positioned in the induction coil. Preliminary testing showed that pins heated best when positioned above the coil. Tempilaq, a temperature monitoring paint, is painted onto the pins, so we can monitor their temperature.

2. Another view of the small PCB sub-assemblies positioned in the coil.

3. This close-up view shows the small PCB sub-assemblies at the beginning of the heating cycle.

4. Here we see at the end of the heating cycle that the tempilaq paint has changed color, indicating that we have reached the target temperature of 500F. The test results show we can heat at the rate of 1 PCB assembly every 0.3 seconds, which exceeds the target of 1 second per PCB. By using UPT-SB3/1000 system, the customer's production rates can grow to meet increasing demand for the parts.



Soldering Copper Coaxial Cable with Copper Connectors

The objective of this application test is to determine heating times for soldering copper connectors onto a copper coaxial cable.

The customer would like to replace hand soldering with soldering irons, with induction soldering. Hand soldering can be labor intensive, and the resulting solder joint is highly dependent on the skill of the operator. Induction soldering allows finite process control, and provides a consistent result.

Materials
- Copper coaxial cable
- Plated copper connectors
- Copper bullet-shaped internal connector
- Copper pin-shaped internal connector
- Solder wire
- Carbon steel

Equipment
UltraHeat UPT-S2 Power Supply
HS-4 Heat Station

Test 1:

Temperature: ~400℉ (788℃)
Power: 1.32 kW
Time: 3 seconds for bullet connector

Test 2:

Temperature: ~400℉ (788℃)
Power: 1.32 kW
Time: 1.5 second for needle connector

Test 3: Bullet-Shaped Center Pin

Temperature: ~400℉ (788℃)
Power: 1.8 kW
Time: 30 seconds of heating time, followed by a 10 second cooling cycle

Test 4: Needle-Shaped Center Pin

Temperature: ~400℉ (788℃)
Power: 1.86 kW
Time: 30 seconds of heating time, followed by a 10 second cooling cycle

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