PROVIDING ADDITIVE SOLUTIONS
ON A GLOBAL SCALE

Repeatable hardening
results in volume production

REDUCE YOUR INDUCTION HARDENING COIL COSTS THROUGH 3D PRINTING

GKN ADDITIVE

VALUE TO OUR CUSTOMER

The deployment of metal 3D printing to manufacture complex, intricate inductor coils with laser AM bonded copper replaces conventional machined and brazed induction hardening (IH) coils.

Complex inductor coils printed directly netshape from 3D models at a fraction of the conventional process lead time are extremely robust and hence much more durable with longer service life.

Benefits of AM inductors include:

- **Reproducible hardening results**
- **Shorter production setup time**
- **Reduction in operation and investment costs (machine utilization)**
- **Longer service life (achieved up to 4 fold increase in service life on current projects)**

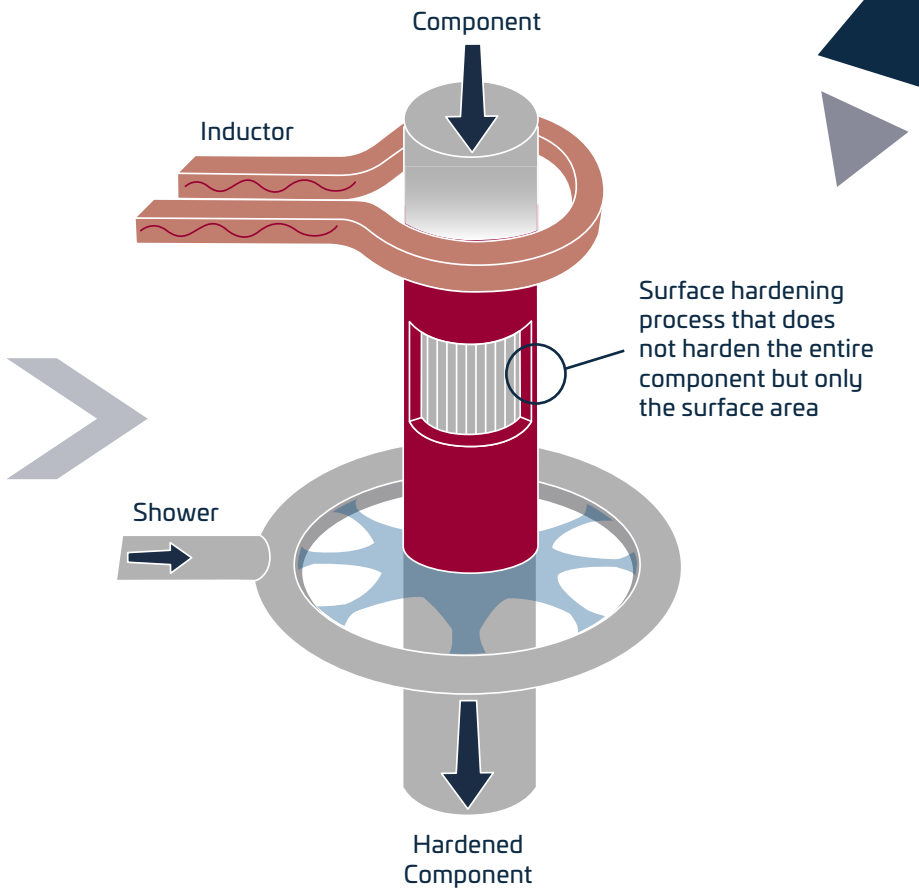
Our 98-99% copper alloy CuCr1Z achieves electrical conductivity of 90% IACS.

INDUCTIVE HARDNESS PARTIALLY INCREASES THE STRENGTH OF THE COMPONENT

In the metal-processing industry, at automotive suppliers and everywhere where certain surface areas of components have to withstand intensive mechanical loads and are exposed to wear, induction hardening is used. It is a surface hardening process that does not harden the entire component but only the surface area.

To achieve surface hardening, a coil of highly conductive copper tubes (the inductor), through which **cooling water** runs under high pressure, encloses the component that is to be hardened. A **high-frequency alternating current** flows through the induction coil, generating a powerful **magnetic field**. The magnetic field induces **eddy currents** in the **boundary layer** of the component, which gives off **frictional heat** and causes it to **glow**. These eddy currents **heat the component surface very quickly** to the temperature required for hardening. After the component is quenched in water for hardening. The depth of the hardened surface layer can be controlled; the higher the frequency, the lower the hardening depth. The heated surface is **quenched** after a fixed time. Strong heating and sudden cooling increase the strength of the component.

The closer the shape of the inductor follows the contour of the component, the more homogeneous is its hardness pattern. Inductors lose efficiency when hardening if their shape is standard versus being customized for the specific task. According to the principle „form follows function“, the shape of the inductor determines the efficiency.



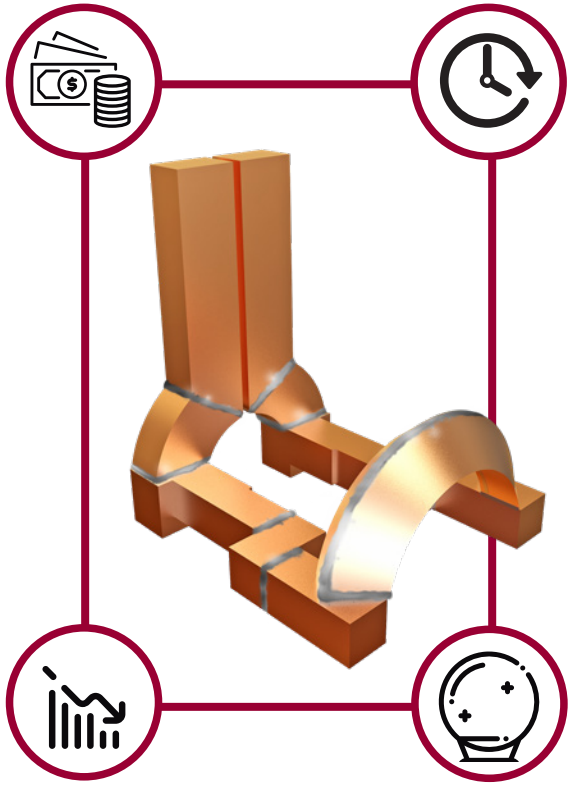
DISADVANTAGES AND RISKS OF TRADITIONAL INDUCTORS

High costs due to geometry production restrictions

The more complex the geometries are, the more individual elements are required to be soldered. When there are multiple solder joints next to each other to achieve the required geometry, several soldering agents with different melting points must be used so that the first solder does not come loose while the second solder is applied. This creates manufacturing challenges as soldering must be performed quickly. Heat will transfer to the first soldered point when soldering the second piece. This additional heat could dissolve the solder from the first point. Even experienced workers find this complicated and tricky work.

Performance loss and shape limitations

Each soldering point disrupts the electrical current flow and causes a significant loss of performance. The inductor's efficiency is not only reduced by soldering joints, but also by the restriction of the inductor's manufacturable geometries. In traditional inductor coil production, geometry options are limited to relatively simple standard shapes. Close coupling of inductors to areas being heat treated results in greater process efficiency.



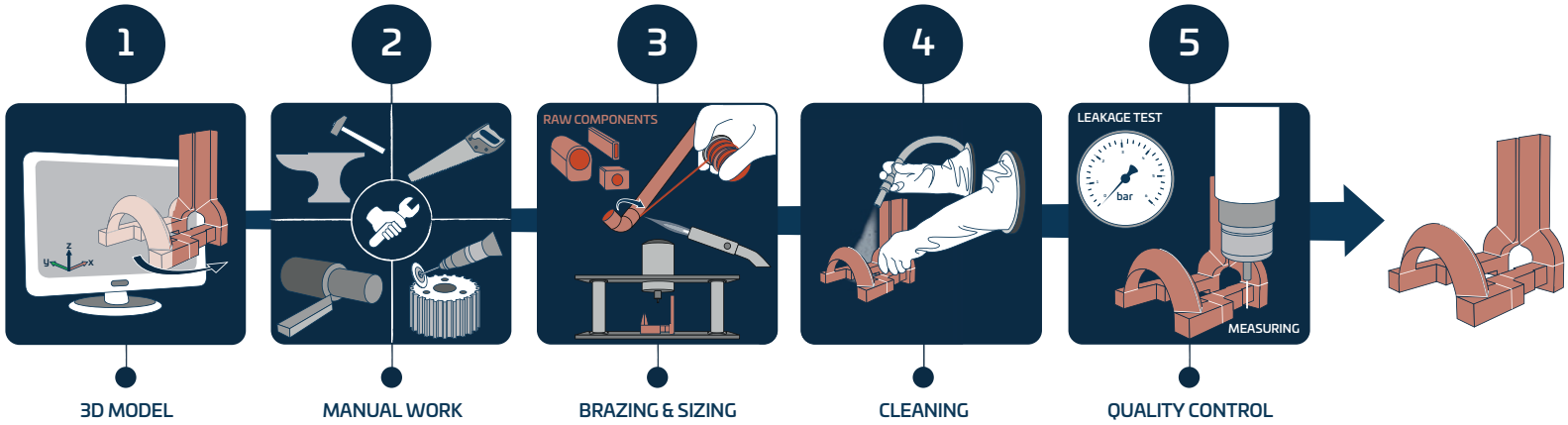
Longer process setup time

Considerably more setup effort exerted with conventional inductors due to differences between same part inductors (manual assembly and brazing during inductor manufacturing process), leads to performance differences which need to be compensated for during production setup.

Poor reliability due to unpredictable service life

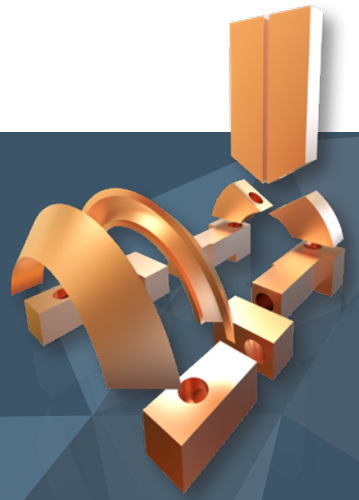
Hand made inductors are subject to manual soldering process which can vary between skilled technicians. This variability inevitably leads to life time performance scatter which is unpredictable and necessitates unplanned break downs and increased number of backup inductors ready for changeover.

TRADITIONALLY MANUFACTURED INDUCTORS– A RISK FACTOR FOR THE HARDENING RESULT

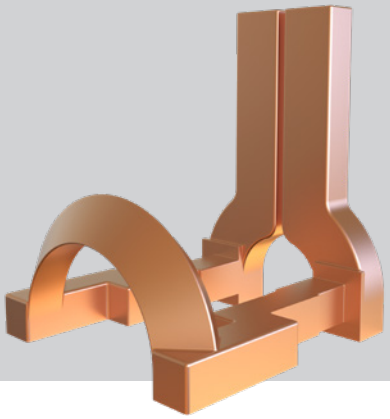


Conventional production of induction coils

Inductor coils undergo several mechanical manufacturing steps during production. An inductor is typically manufactured from several machined components which are then soldered together. This is a time consuming and can prove difficult to manufacture any two inductors with identical performance due to the traditional “jig saw” manufacturing process.



THE FUTURE OF INDUCTOR COILS LIES WITH METAL 3D PRINTING



Less energy and enhanced hardening results

Selective laser powder melting builds up layers of the 3D net shape one-piece inductor. This single piece construction gives an inductor geometry with much higher strength than the conventional manufacturing process, and is far more robust against stresses during heat treatment and also during production.
The 3D printed inductor has a higher load-bearing capacity, even at critical areas of a highly complex component geometry. In addition, the new 3D printed process produces inductor coils that won't disturb the magnetic field normally caused by the soldering joints.
Overall net effect is a higher strength inductor with superior energy efficiency during use.

Reduction in storage and setup costs

The reproducible production of the exact geometry every time now enables a reproducible and reliable production process with more efficient set-up times.
Utilization of production equipment is significantly enhanced lowering the operational and investment costs with minimal spare inductors required.

Higher service life and competitiveness

3D printing can be used for all complexities of inductors form the most simple design, through to the most complex with the benefits of prolonged inductor reliability and hence life cycles considerably longer than conventionally manufactured inductors.
GKN has experienced increased service life by up to 400%.

Additional benefits of 3D AM inductors

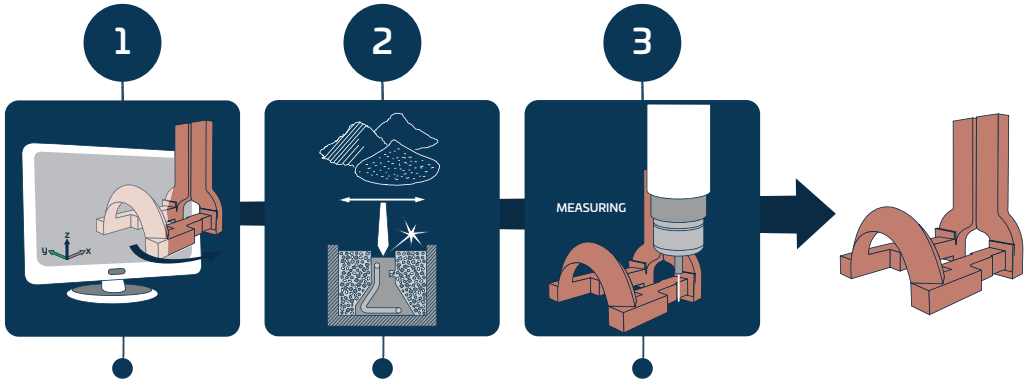
Uniform precision shape tailored to the component

Enhanced inductor cooling through higher precision manufacturing resulting in high performance 3D cooling channels

Reproducible serial production performance

ADDITIVE MANUFACTURING FOR INDUCTION COIL PRODUCTION

Today, 3D printing (selective laser melting) solves the problems arising from conventional inductor production and enables reproducible hardening results in series for the first time.

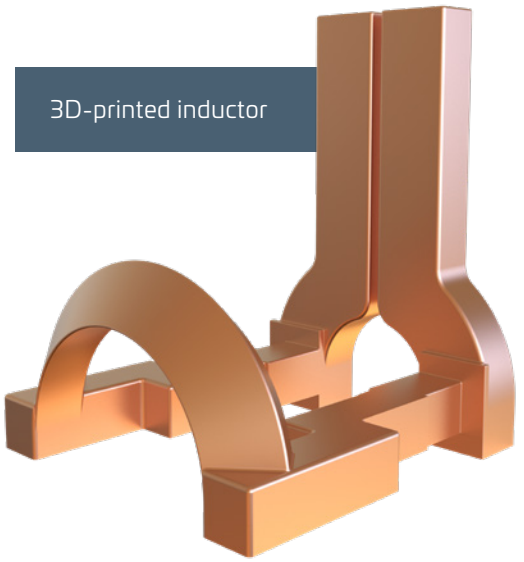


Inductors, that are 3D printed without soldered joints, require less energy, have higher efficiency. All of which results in enhanced hardened uniformly on production parts.

Microscopy of manually manufactured inductor coil shows hardening profile with varying hardness penetration depth

Microscopy of 3D-printed copper coil shows a more homogenous hardening profile

ALL-INCLUSIVE PACKAGE FOR THE INDUCTOR INDUSTRY



If you are a manufacturer considering using 3D printing to produce your inductor coils, you need to find a full-service provider. Additionally, you want a full-service provider that is not only dedicated to its customers, but also understands the materials to be used and can provide proper technical advice throughout the production process. A proper 3D printing supplier should be able to offer fully customized parts and offer geometry optimization that enables the production of identical inductors in series with a global quality standard.

GKN Powder Metallurgy can help you to produce inductor geometries with reproducible quality and uniform hardening results at a low cost. Our 3D printing process can offer fully customized inductors and guarantee a 3-4 times higher service life than conventionally manufactured inductors.

We ensure that the process is user-friendly and we offer ready-to-use 3D printed inductors. This includes:

- **Magnetic field simulation to ensure there is no interference**
- **Engineering support throughout the entire process**
- **The entire assembly:**
  - Copper inductor coils
  - Shower, which helps to rapidly cool the workpiece heated by induction hardening
  - Copper connecting plates that fix the inductor to the machine and connect the water supply for cooling channels

GKN ADDITIVE

About GKN Additives

GKN Additive is a digital manufacturer of metal AM parts and materials for prototypes, medium series and the aftermarket. Our AM production plants are embedded in Industry 4.0, backed by an intelligent global print network for maximum efficiency and prompt delivery to our customers. What sets us apart is our history.

GKN Additive builds on GKN Powder Metallurgy's dual expertise in powder production and metal processing to drive industrialization across the whole Additive Manufacturing value chain.

From advanced metal powders to design and manufacturing services, we drive new technologies to the limit to make technology simpler, faster and more accessible.

Connect with us

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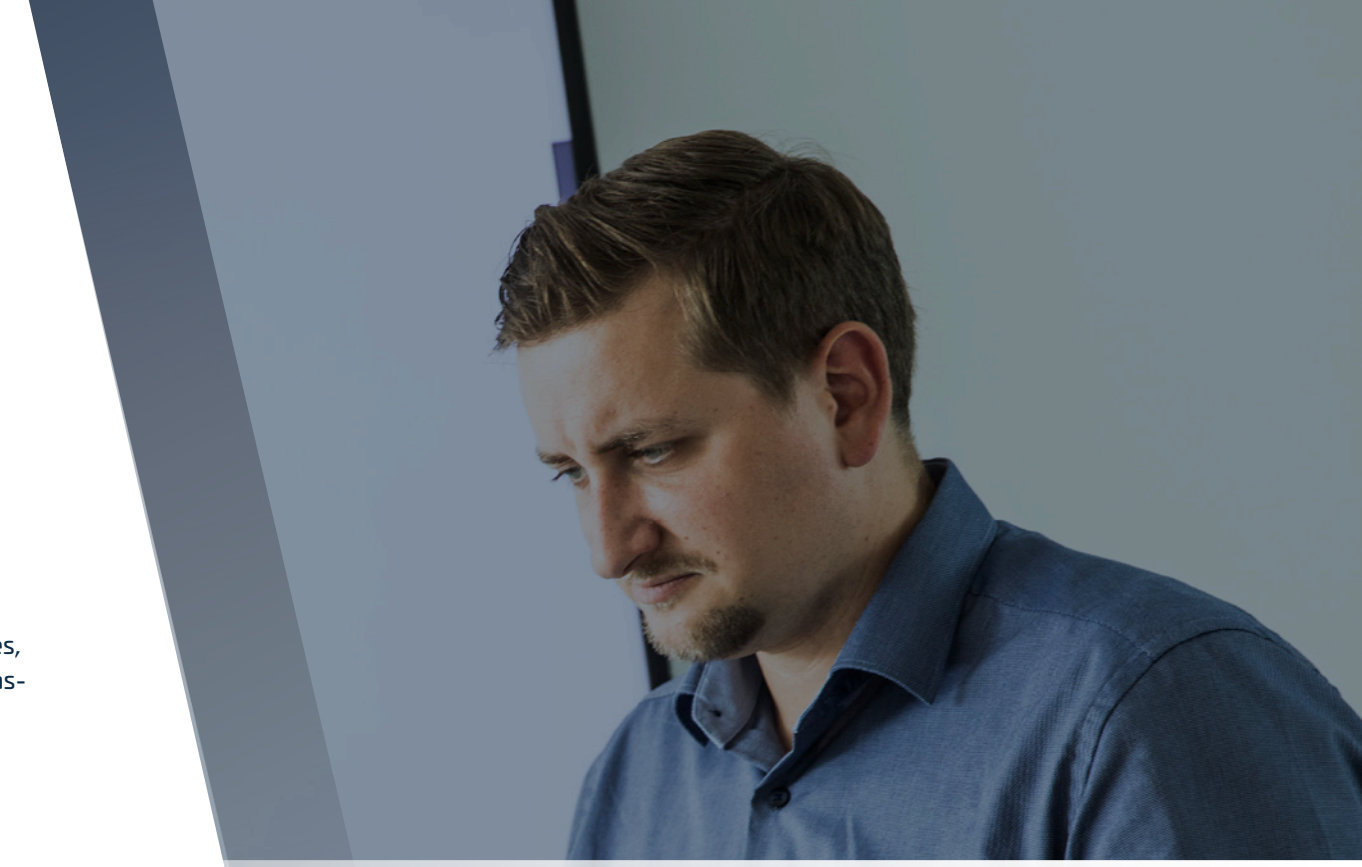

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