



Copper-Based High-Temperature Materials

Creating
powerful
materials.



Looks like copper, but is actually more:
CEP DISCUP®: A copper-based high-temperature material made by CEP

AT FIRST GLANCE FAMILIAR. AT SECOND GLANCE: UNRIVALED.

CEP's copper-based high-temperature materials look like copper; and like copper, they're excellent conductors of electricity and heat. But here the similarity ends: If the copper-based high-temperature materials are heated up to 900 °C during their processing or use, then they'll retain considerably more of their strength, due to a very stable structure, than conventional materials. What is even more unusual is the fact that they regain their original strength after they've cooled off. And that is well beyond that of copper – actually similar to that of unalloyed steel.

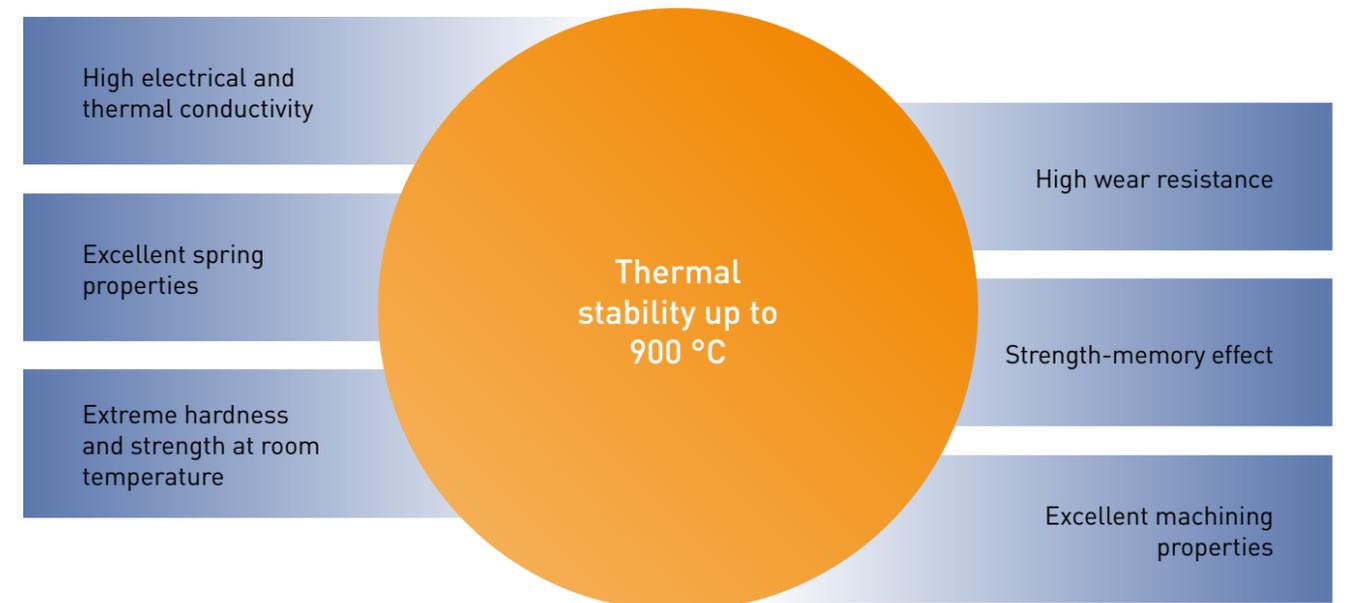
With its unique combination of high conductivity, thermal stability and strength-memory effect, CEP's copper-based high-temperature materials provide entirely new fields of application. Where design engineers had to make compromises in the past in order to develop particular components – at the expense of functionality and price – they're now able to achieve their objectives directly.

CEP DISCUP® is the primary element for CEP's copper-based high-temperature materials. It is available – depending on your needs and requirements – in different strength categories.

CEP DISCUP® VOLT is an alternative for highly resistant electric contacts. It is suitable, for example, for line wires which are exposed to high mechanical stress, for adhesive-free contacts in heavy current technology or for durable electrode caps during resistance welding.

CEP DISCUP®+Cu is a compound material. It unites with great efficiency the properties of the high-temperature material with those of a conventional metal. For example, it is the source material for durable compound current contact tips in arc welding. CEP DISCUP® compounds with other materials permit the production of components at lower costs – or produce entirely new property combinations.

The properties of CEP's copper-based high-temperature materials

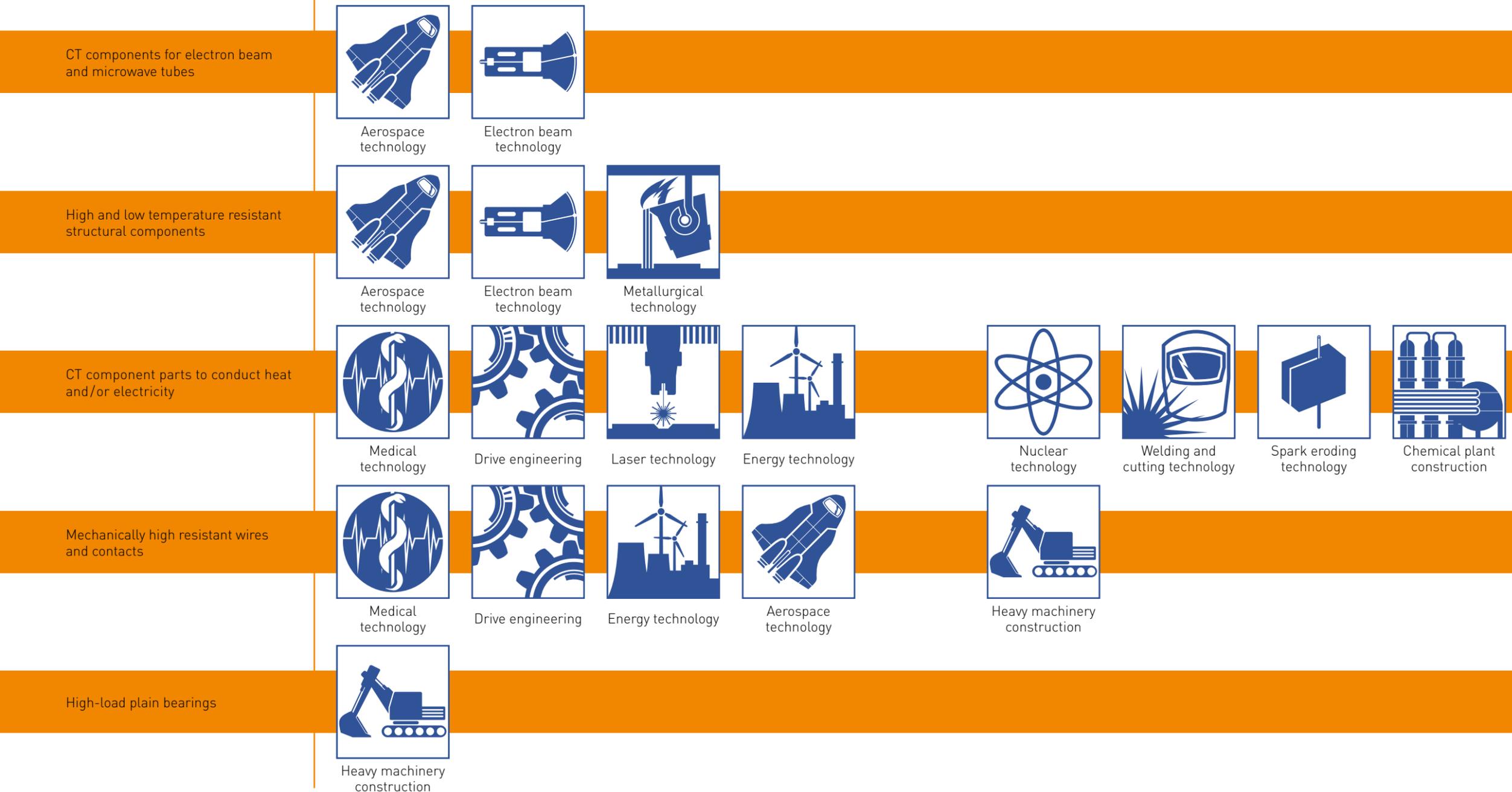


DO SOMETHING WITH IT.

Thanks to their unique properties, such CEP copper-based high-temperature materials as CEP DISCUP® are ideal for sophisticated applications in the most diverse technological branches.

Thinking about using these materials is always well worth the effort when it comes to outsmarting the “magic triangle” of high temperature, strength and conductivity. When it comes to so-called conductivity-temperature

applications (abbreviated as CT applications), for which electrical and/or thermal conductivity as well as thermal stability are all required at the same time, CEP’s materials are in a league of their own. Sometimes even their other characteristic features come into play – either additionally or by themselves. The below diagram shows what is possible. From a production point of view, there are almost no limits to the application of copper-based high-temperature materials. They can be easily formed, machined, polished or also brazed.



SEMI-FINISHED PRODUCTS. OR FINISHED PRODUCTS.

Because CEP has its own state-of-the-art mechanical production facility, it is often possible to have parts made from copper-based high-temperature materials which are produced according to your drawings. Already today CEP delivers, for example, numerous compound contact tips for the most diverse welding systems.

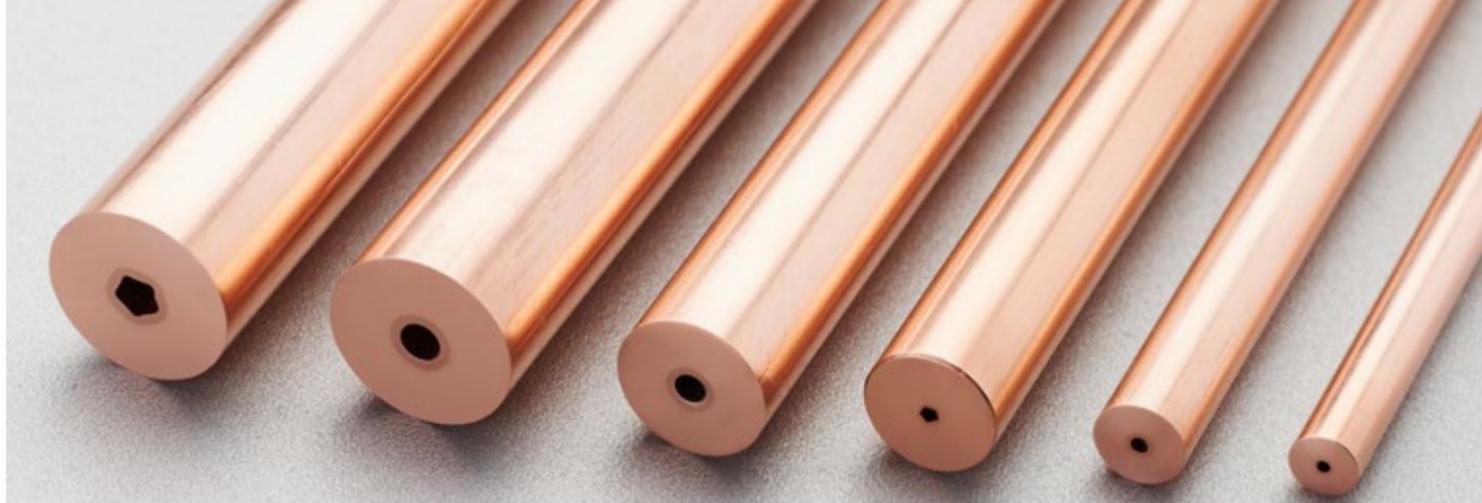
Rod material is generally available as a semi-finished product – usually with circular cross-sections. Upon request, it is also possible to get square or polygonal cross-sections. It is also possible to order wires upon request.

Compound materials like CEP DISCUP®+Cu are available as tubes – either with circular or star-shaped cross-sections. The latter is recommended for internal high wear which can, for example, occur with wire guides in welding or spark eroding applications.

If you need advice, have questions, or wish to place an order, you can contact CEP directly. Orders are shipped right from the plant. Please visit our website: www.cep-freiberg.de/en if you need more background information. At the website, you can already specify your order for compound contact tips.

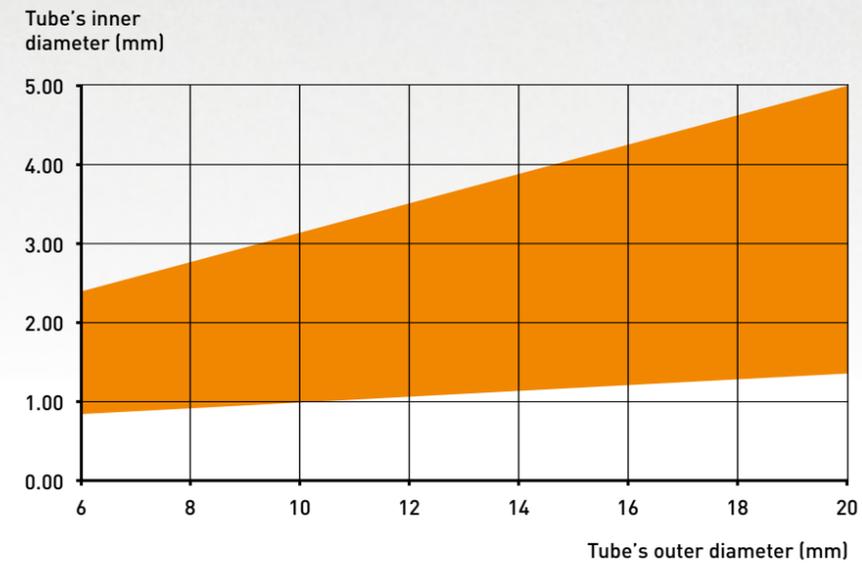


Compound contact tips made from CEP DISCUP®+Cu, products produced by CEP



Tubes made from the compound material CEP DISCUP®+Cu

CEP DISCUP®+Cu: dimensions of tubes



Circular or star-shaped internal cross-sections are available. For the star-shaped version, the inner diameter refers to the small inscribed circle.

CEP DISCUP®: available dimensions of round rods

| | |
|----------------|-------------------|
| Diameter | 3.0 mm to 30.3 mm |
| Maximum length | 3,200 mm |

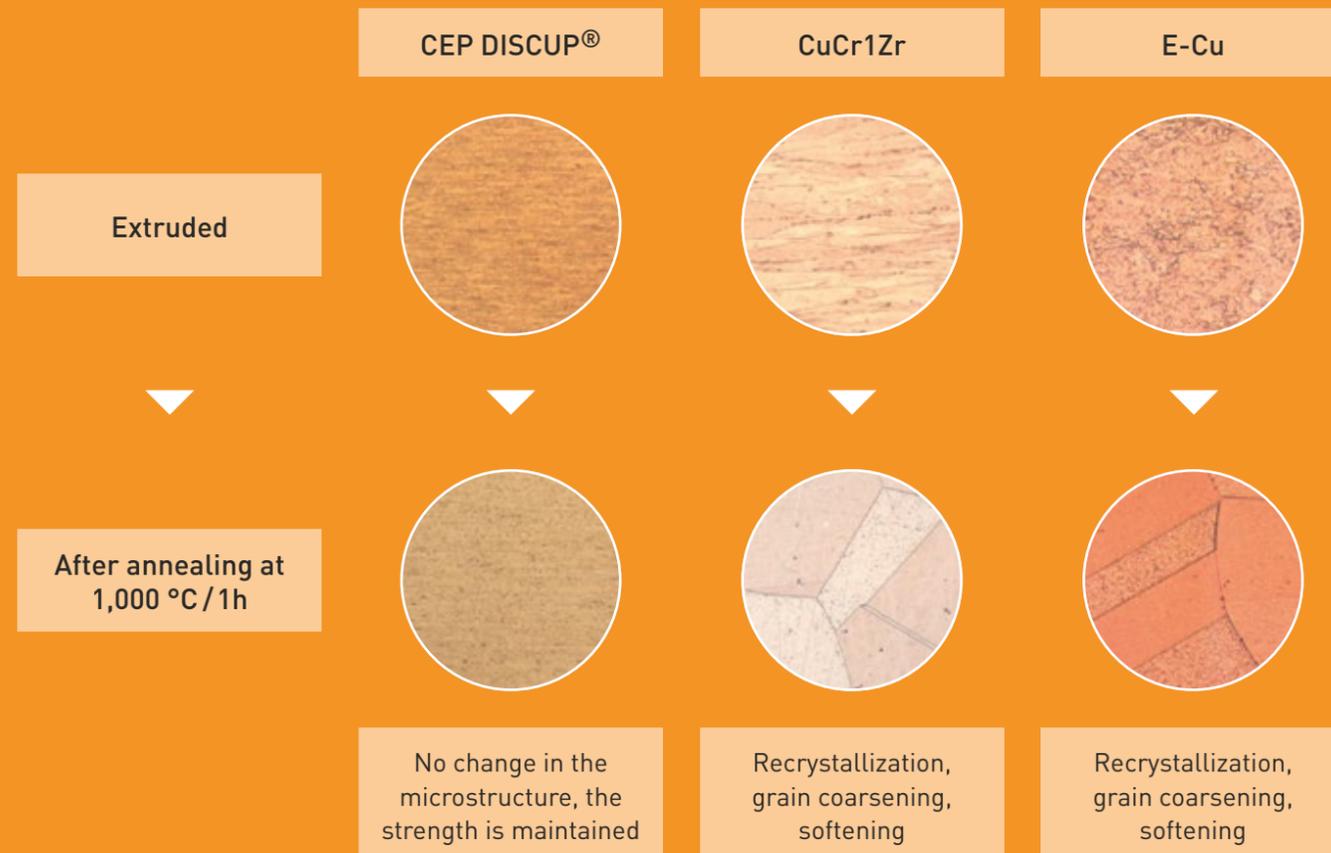
THE DIFFERENCE IS IN THE DETAIL.

CEP's copper-based high-temperature materials belong to the ODS (Oxide Dispersion Strengthened) copper group. These are powder metallurgical materials which get their strength from small, non-metallic precipitations in the structure. The difference to other representatives of this group is found in the production process: Reaction milling and /or mechanical alloying, followed by forming through extrusion. Both ensure that the properties develop correctly – and stay that way.

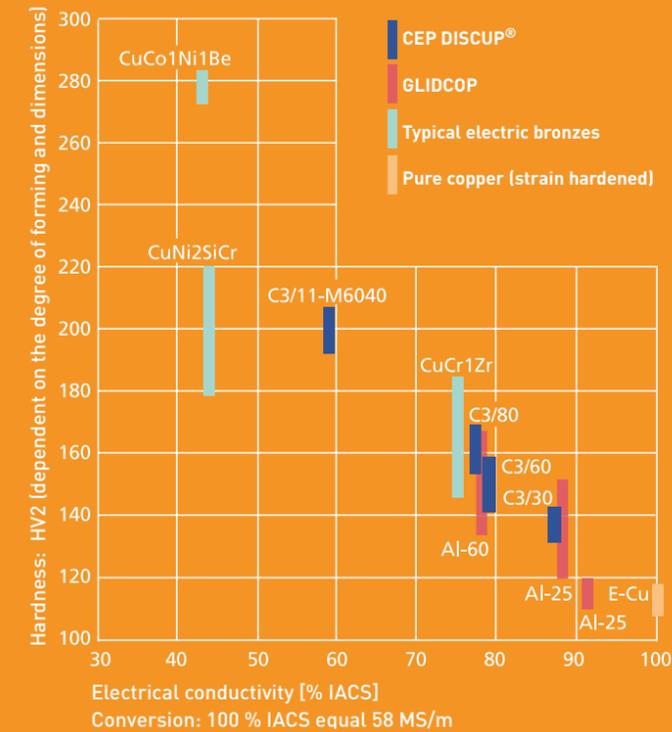
A special feature of the materials is the restored strength after intense heating, i.e. strength-memory effect. On the one hand, this is due to the mechanism of the precipitation hardening and, on the other hand, due to the special production process. The below figure shows the metallurgical behavior: While the structure of pure copper and conventional copper alloys like CuCr1Zr irreversibly coarsen after heating, CEP DISCUP®'s structure stays fine without any change.

Strength-memory effect

Comparison of CEP DISCUP®'s, CuCr1Zr's and pure copper's structures before and after heat treatment



Hardness and electrical conductivity CEP DISCUP® compared to other electro materials



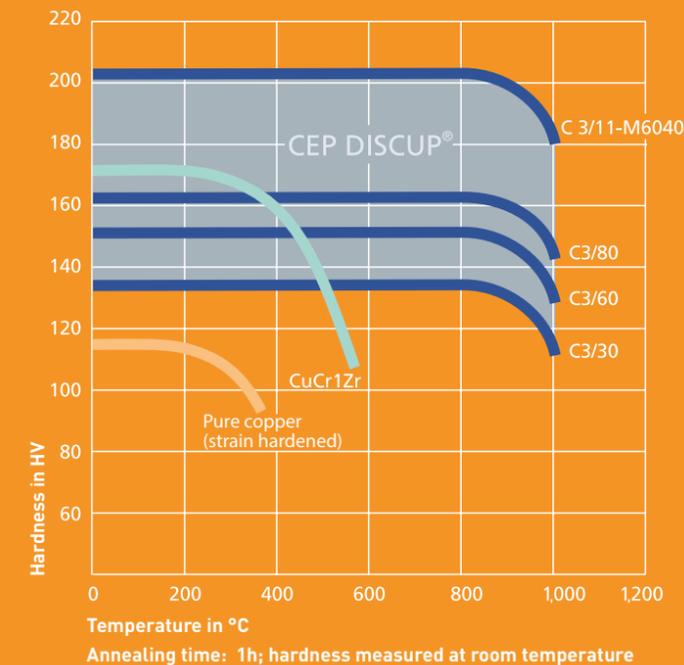
Conductive like copper, hard and solid like steel
Properties of CEP DISCUP® in four exemplary strength classes at room temperature

| CEP DISCUP® | C3/30 | C3/60 | C3/80 | C3/11-M6040 |
|---------------------------------|-----------|-----------|-----------|-------------|
| Hardness HV2 | 136 ± 5 | 152 ± 5 | 161 ± 6 | 202 ± 9 |
| Tensile strength MPa | 360 - 400 | 450 - 510 | 470 - 540 | 600 - 660 |
| 0.2-% offset yield strength MPa | 300 - 340 | 360 - 400 | 380 - 420 | 480 - 520 |
| Strain % | 15 - 20 | 15 - 20 | 8 - 12 | 6 - 10 |
| Elec. conductivity % IACS | 86 ± 2 | 79 ± 3 | 77 ± 3 | 59 ± 4 |

These data are approximate values and can vary depending on the processing method. Deviations are possible.

Thermal stability

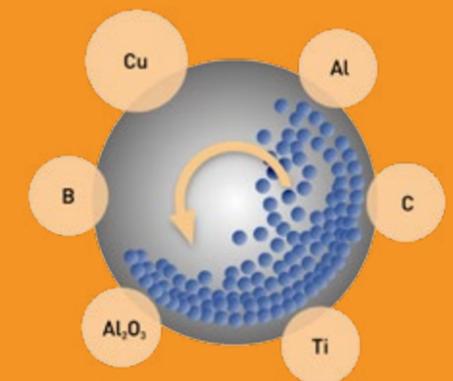
Comparison of CEP DISCUP®'s, pure copper's and CuCr1Zr's room temperature hardening after annealing



Production process

for CEP's copper-based high-temperature materials

1. Reaction milling / mechanical alloying



2. Powder compaction (pre-compaction of green bodies)
3. Extrusion
4. Drawing
5. Straightening
6. Machining



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