

Electron Beam Welding Vacuum Brazing

Libor Dupák

Dep. Electron and Plasma Technologies
Group of Electron Beam Technologies

Libor.Dupak@isibrno.cz ebt.isibrno.cz

Electron Beam Welding

Basic principle:

Heating by incident electron beam

No additional material

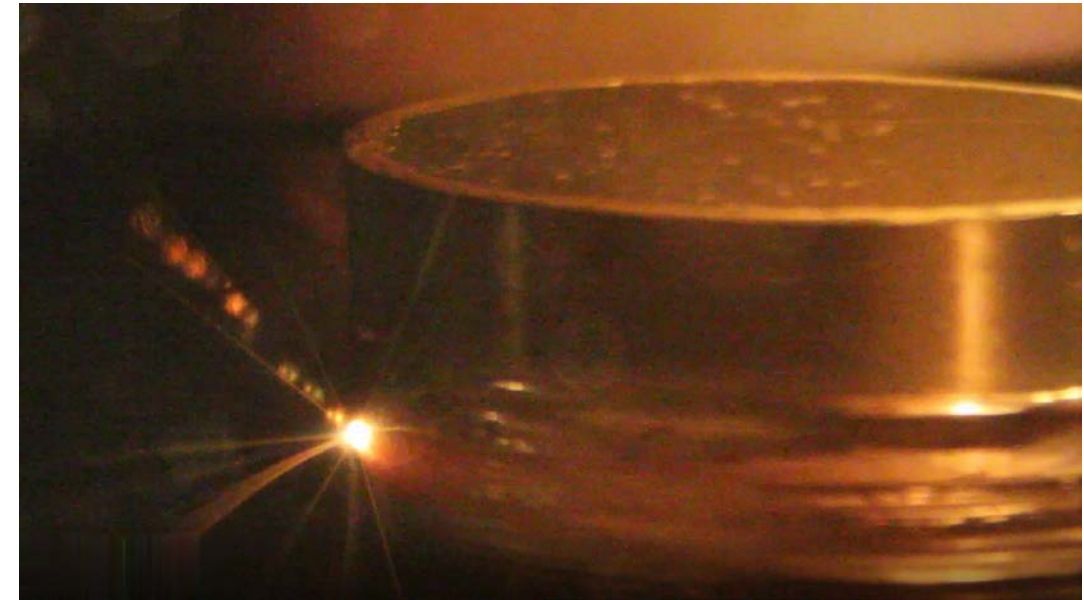
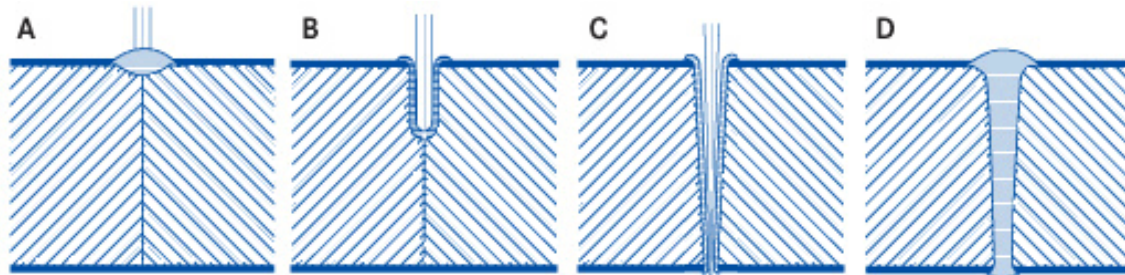
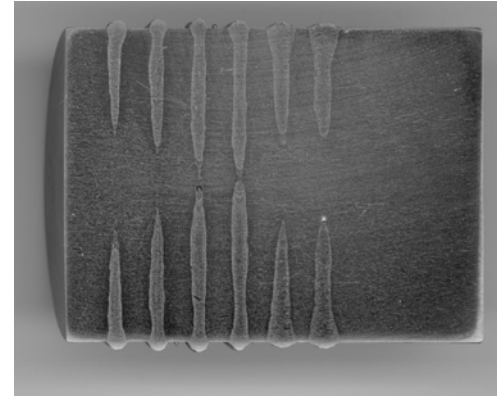
Results:

- narrow and deep welds
- low heat affected zone
- low thermal deformation
- clean welds - vacuum

Steel, 10 mm



stainless steel, Ø30 mm



Materials

wide range of materials

- stainless and alloy steel, copper, aluminium alloys
- Reactive metals – titanium, zirconium
- Refractive metals – tungsten, molybdenum, tantalum
- special alloys – Inconel, permalloy
- Dissimilar metal combinations – Ti-Al

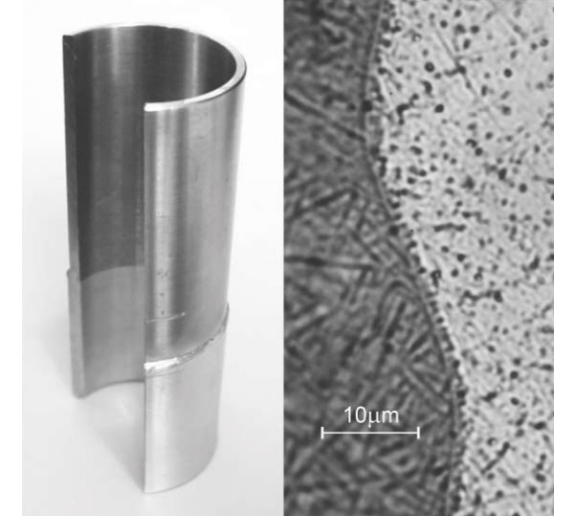


Stator body, 8 welds

Tantalum target
Ø30 mm, Ø8 mm



Zr tubes, Ø10 mm

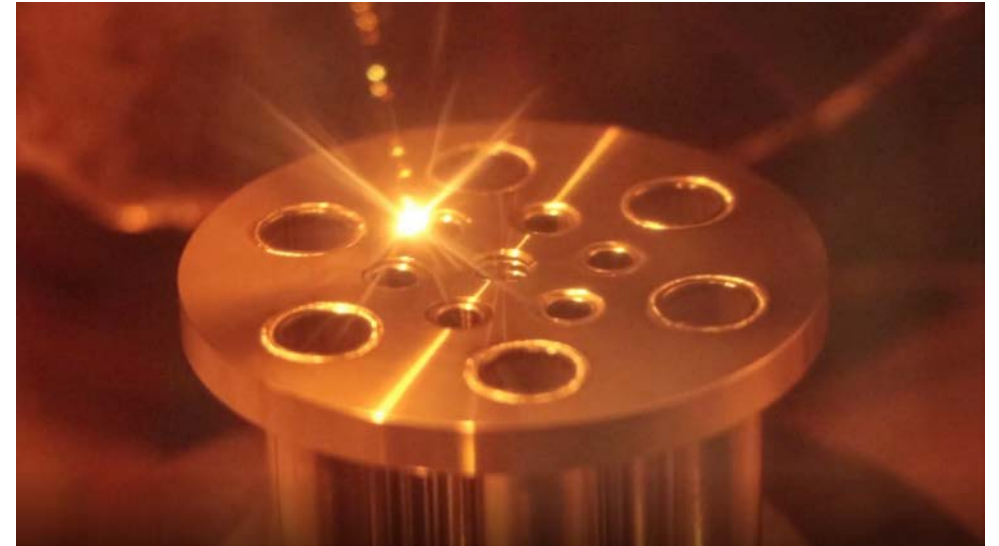
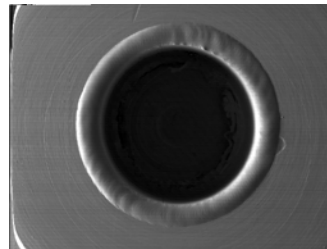
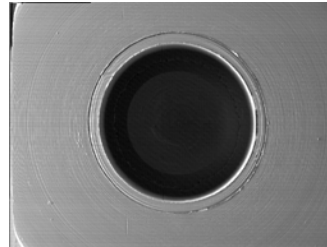
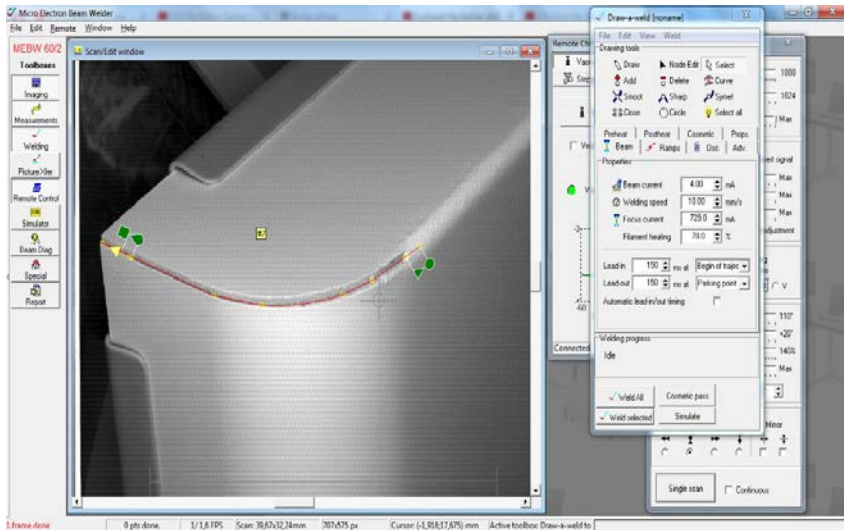


Ti-Al

cryostat



Beam control



Flange with feedthroughs



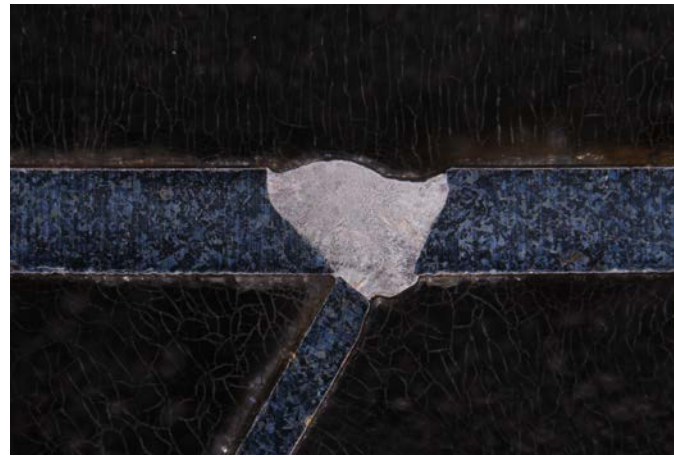
Square weld, $a=30$ mm



Precise welds



feedthrough, $\varnothing 4$ mm



rib joint, thickness 1 mm/0.5 mm



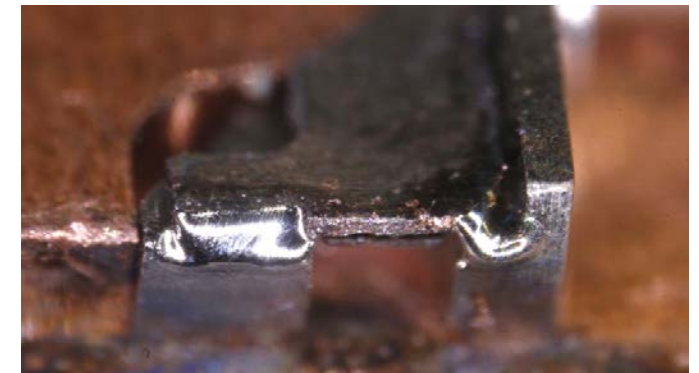
bellow – flange
0.3 mm thick,
 $\varnothing 10$ mm



Cu pins, $\varnothing 2$ mm



Iridium square tube,
2x2 mm, 0.2 mm thick

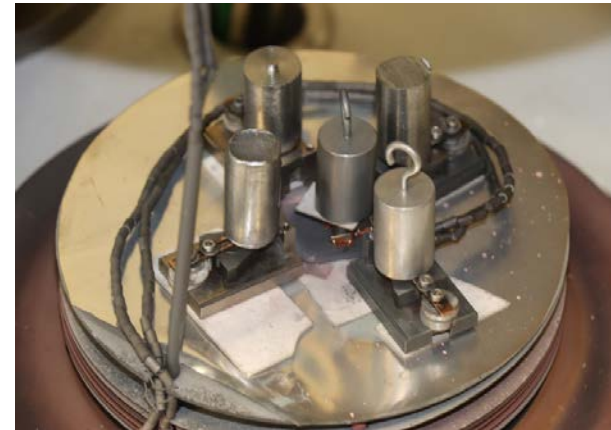


TEM Sample holder, 3 mm

Vacuum brazing

Basic principle:

- two or more metal items are joined by melting a filler metal which flows into the joint
- capillary brazing
- $T > 500\text{ °C}$
(700 – 1200 °C)
- no flux
- vacuum cleanness
($\sim 10^{-2}$ - 10^{-4} Pa)
- complicated joints

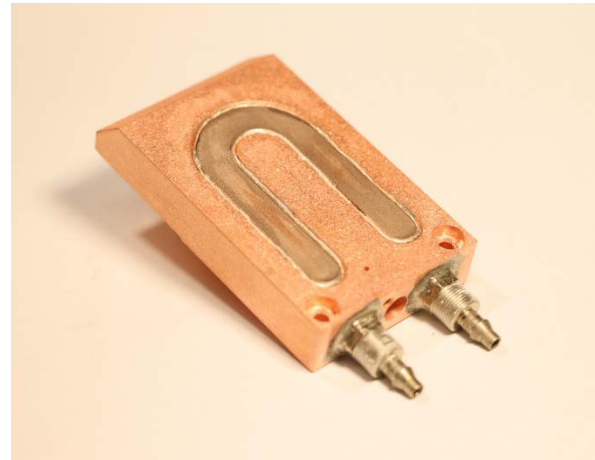


Various filler metals for various metals

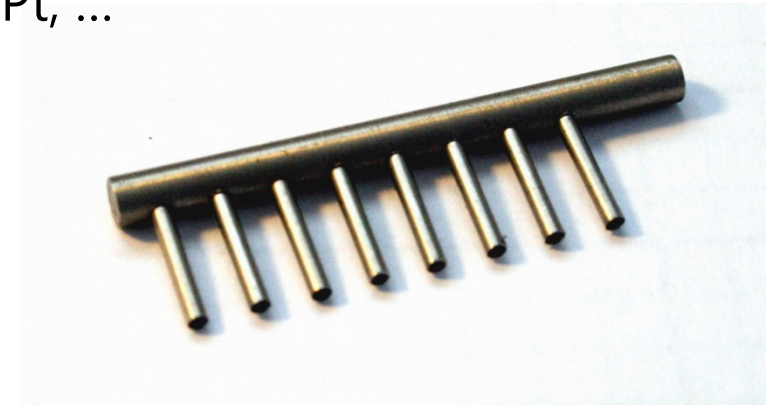
- metals: steel/stainless steel, copper, titanium, ... + combinations
- filler metals: clean metals or alloys based on Cu, Ag, Au, Ni, Pd/Pt, ...
- forms: wire, foil, paste, powder



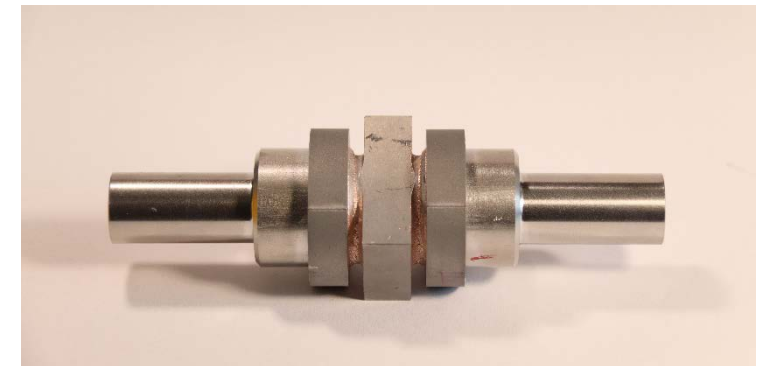
Steel brazed with copper



cooler: 2 joins
Cu-Cu: Ag72Cu
Stainless steel-Cu: Microbraz



Steel coupler, $\varnothing 5$ mm – $\varnothing 2$ mm



Stainless steel – tungsten pressure test tube

Active brazing

- filler metal with titanium
- can join nonmetals like glass and ceramics



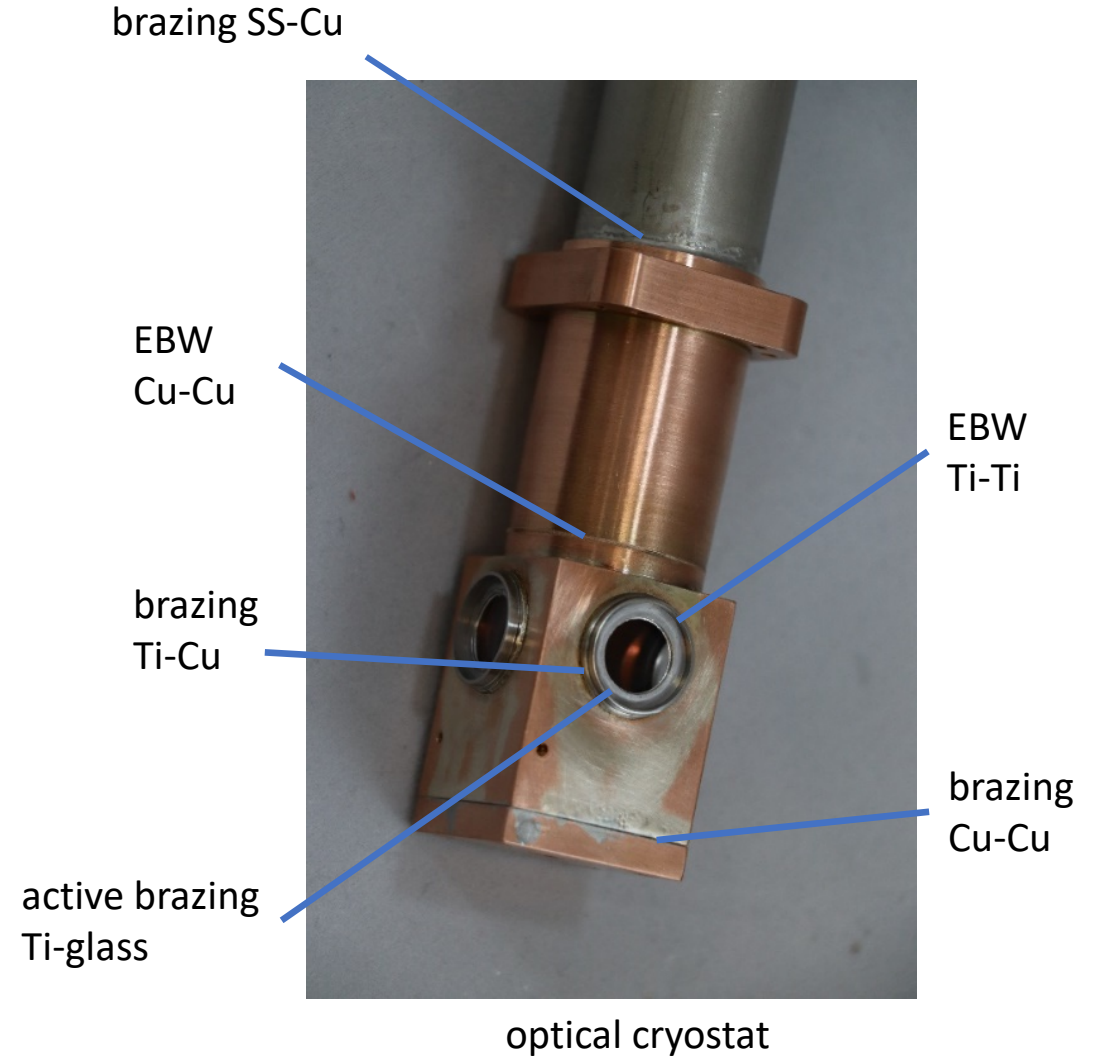
diamond – carbide
3 mm



windows – titanium to glass
In / Sn based



stainless steel - ceramics



Thank you for your attention.

Libor Dupák

libor.dupak@isibrno.cz

ebt.isibrno.cz

www.isibrno.cz

