

## CAPABILITIES

- **Electron-optical monitoring (resolution  $\leq 10\mu\text{m}$ )**  
Viewing system based on back-scattered electrons enabling high-precision monitoring and positioning
- **Integrated electron-optical seam tracking**  
On- and off-line seam tracking or joint detection before or during welding using electron-optical monitoring and image analysis
- **CCD-Camera**  
Optical monitoring system using integrated CCD camera with video recording capabilities
- **Dynamic lens system**  
Focus lens with high dynamic range for fast focus adjustment in the kHz range e.g. for focus wobbling or multi focus applications
- **Fast beam deflection**  
Deflection of the electron beam across the field of view with a slew rate of up to  $\pm 0.6^\circ/\mu\text{s}$
- **Scanning like welding**  
Electron-optical scanning of the joint using the welding program in order to evaluate possible external influences
- **Free programming of beam deflection pattern**  
Beam deflection pattern freely programmable in a matrix of  $65535 \times 65535$  points
- **Integrated X-ray sensor**  
X-ray optical monitoring and analysis of the welding seam and/or detection of hidden welding gap
- **Siemens Sinumerik 840D Powerline CNC**  
Control of seven mechanical axes and four electrical axes
- **Integrated 3-axis CNC-controlled wire-feed unit**  
Adding filling material to welding process or coating of surface (wire diameter: 0.6 and 2.0mm)
- **Process data recording**  
Recording of relevant process data with a cycle time of approx. 3ms

## CONTACT

### Contact person

Dipl.-Ing. Dr.techn. Norbert Enzinger  
Associate Professor

### Graz University of Technology

Institute for Materials Science and Welding  
Kopernikusgasse 24/I  
8010 Graz, Austria

Tel. office: +43 (0) 316 873 7182

Email: [norbert.enzinger@tugraz.at](mailto:norbert.enzinger@tugraz.at)

Internet: <http://www.iws.tugraz.at/>



**Graz University of Technology**  
Institute for Materials Science and Welding

**Electron beam chamber machine**  
**EBG 45-150 K14**



**Welding • Hardening • Coating**



## INTRODUCTION

The new electron beam welding machine EBG 45-150 K14 is a highly innovative device for treating materials using an electron beam in vacuum. Due to its chamber size of 1.4m<sup>3</sup>, its maximum beam power of 45kW and its diverse functions, it offers unique possibilities to handle a broad range of metallic materials and material combinations.

### Electron beam welding

The machine can perform welding with a penetration from less than one millimetre up to 50mm (copper), 150mm (steel) or 200mm (aluminium). Weld distortions and other negative influences of the component can almost completely be eliminated due to the narrow and parallel welding seams. Influences on the welding process from oxygen and other atmospheric gases do not occur due to operation in a high vacuum (<10<sup>-3</sup> mbar). This means that reactive materials, such as titanium, can also be processed. The intelligent compact wire feed unit furthermore allows welding using filler materials so that the characteristics of the weld seam can be selectively influenced. A powerful pumping unit produces a high vacuum in the chamber which is suitable for treating demanding materials. This vacuum allows reactive materials to be EB welded, considerably reduces vaporization of the welded parts and ensures the best possible reproducibility of the welding results.

### Electron beam hardening

The device allows surface layer hardening of perlitic steels as well as grey iron and cast iron up to hardening depths of 1.5mm and with hardening values of up to 60HRC or more, depending on the alloy composition of the basic material. Any resulting distortion can usually be neglected. Scaling or other negative influences on the surface do not occur.

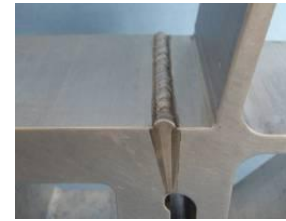
### Electron beam coating

With the help of the integrated wire-feed unit, coating using filler materials as part of an effective repair technology or to improve surface characteristics (wear resistance, etc.) can be carried out.

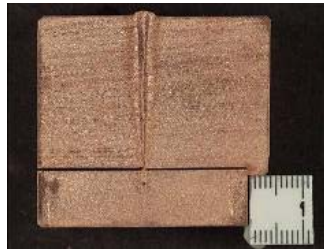
## APPLICATION EXAMPLES



Bronze/steel, 30mm



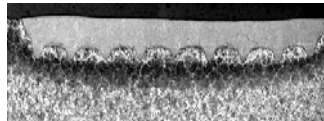
Aluminium, 40mm



Copper, 60mm



EB-hardening



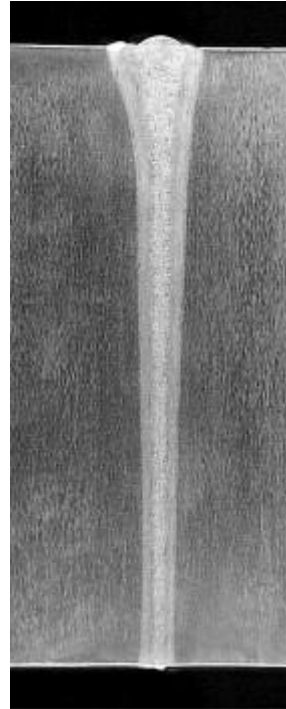
EB-remelting



EB-coating



Oxygen-free copper



Steel, up to 150mm



TiAl6V4

## TECHNICAL DATA

### Power specifications

- Power: max. 45kW
- High voltage: 150kV
- Beam current: 0.1 – 300mA
- Beam current constant or pulsed (can be modulated) up to 1000kHz
- Beam deflection (freely programmable)
- Dynamic lens (freely programmable)

### Vacuum data

- Chamber evacuation time: < 4 minutes
- Working vacuum: 5x10<sup>-3</sup> mbar
- Final pressure: 1x10<sup>-4</sup> mbar
- Working vacuum of beam generator: 5x10<sup>-5</sup> mbar

### Working area X and Y axis (without rotary-tilting-device)

- Travel X and Y: max. 600mm x 400mm
- Height above table: 750mm
- Maximum component weight: 500kg

### Working area A and B axis (rotary-tilting-device)

- Travel X and Y:  
300mm x 700mm (device horizontal) and/or  
500mm x 700mm (device vertical)
- Maximum component dimensions: 400mm x 400mm
- Loading capacity of rotary-tilting-device: max. 200kg

### Travel speed

- Max. travel speed X and Y axis: 100mm/s
- Max. travel speed A axis: 30rpm
- Max. delivery speed B axis: 3000°/min

### Wire feed unit

- Usable wire diameter: 0.6mm, 2.0mm
- Max. wire feeding speed: 10m/min

The electron beam machine fulfils requirements of  
DIN EN ISO 14744