EBM
ELECTRON BEAM MACHINE

The Electron Beam Opens the Way to the Future of Processing
Mitsubishi Electron Beam Machines demonstrate their superiority in the areas of precision welding, alloying, and surface modification, as well as brazing.

Since 1969, when Mitsubishi Electric developed the first model of its own electron beam machine (EBM), Mitsubishi Electric has maintained its position as the leading manufacturer in this field, supplying various types of EBM to leading companies in a range of industries, including the automotive manufacturing industry, as well as research institutes and other organizations. EBM use has steadily expanded in the IT industry and other high technology areas.
The Electron Beam Opens Up New Territory in Processing

Electron beam processing has achieved a level of high-grade processing that goes beyond the concept of simply welding, and it continues to evolve. The superior controllability of the electron beam creates new applications that deliver high added value.

**Solutions achieved by changing a manufacturing method**

**From one-piece processing to segmented processing**
- **Use:** Manufacture of transmission gears
  - Reduction in size and weight
  - Simplification of machining
  - Increased productivity
  - Optimization of materials for individual sections
  - Cost reduction

**Partial quenching with an electron beam**
- **Use:** Manufacture of clutches
  - Quenching in the furnace (batch process) can be dispensed with.
  - The quenching process can easily be incorporated into the production line.
  - Surface modification can be performed locally on just the required area.
  - Lower heat input achieves energy savings and reduces power bills.
  - The number of process steps can be reduced by the elimination of strain relief.

---

**Breakthrough**

**Solutions achieved with the electron beam**

**Seal welding**
- **Use:** Manufacture of copper diaphragms
  - Vacuum sealing in a vacuum
  - Applicable to edge welding and lap welding of thin plate

**Electron beam brazing**
- **Use:** Jointing circuits of nickel hydride batteries for hybrid cars
  - Thermal damage is minimized as just the specified spot is heated momentarily.
  - The beam deflection yields high productivity; spattering is eliminated.
  - Joints are stable due to processing in a vacuum.
  - Ultra-high speed brazing is performed in just milliseconds with a tightly focused beam exceeding 4kW.
  - Dowelizing (90% reduction in volume) of battery modules; trimming of weight (60% reduction in mass) and streamlining for high efficiency (70% increase in power density) are achieved.
Electron Beam Is Freely Controlled with a Magnetic Field

- **Principle of electron beam welding**
  Electron beam welding is a thermal processing method that uses irradiation with an electron beam. The electrons are accelerated to a high speed and the beam converged to a high density in a vacuum, and when the electrons strike the workpiece, the metal is melted and welded instantaneously. The energy density of the electron beam can be 5000 times as high as that of arc welding, or even higher. Also, no oxidation of the workpiece takes place as the welding is done in a vacuum. This makes it eminently suitable for welding easily oxidizable metals, such as titanium and molybdenum.

- **Prevention of solidification cracking with beam oscillation in the direction of travel**
  Diffuse impurities without welding bead width.

- **Removal of blow holes with circular oscillation**
  Circular oscillation

- **Preheating and post heating with surface deflection**
  Surface deflection

- **Comparison of welding methods**
  Electron beam welding produces a bead about one-tenth to one-twentieth as wide as arc welding and laser welding in the atmosphere.

- **Effects of heat input**
  Thermal strain results from material contraction after melting and an electron beam produces a smaller molten region than a laser beam, leading to less thermal strain from the turner.

- **Processing performance**
  Thermal strain results from material contraction after melting and an electron beam produces a smaller molten region than a laser beam, leading to less thermal strain from the turner.

- **Electromagnetic focusing lens**
  Focal position can be set freely with electromagnetic force (lens current)

- **Deflection lens**
  The beam can be moved freely to the desired X-Y coordinates by setting the deflection field. With its negligible inertia, the beam can be controlled with electric speed.

- **Expansion of processing variations through the control of beam scanning**
  High-speed welding with beam scanning

- **Welding performance of electron beam (at various welding speed)**
  

- **Diagram of cathode ray tube**
  Diagram of EBM electron gun

- **Configuration of the electron gun**
  Electron beam generating section
  Collimator
  Grid (Meshed)
  Cathode
  Anode
  Lens system
  Lens No. 1 (focus)
  Lens No. 2 (convergence)
  Deflection lens
  Electron beam
  Workpiece to be welded

- **External appearance and principle of rod cathode**
  Impulse power supply
  Filament
  Impulse electron flow
  Rod cathode
  Electron beam

- **Dimensions for electron beam output (KV)**

- **Depth of penetration (mm)**

- **Welding speed (m/min)**

- **Metal section properties**
  

- **Electron beam and laser welding**
  Laser welding
  Electron beam welding

- **Image diagram**
  <Image diagram>
A wide array of variations according to type of use and processing

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Index type</th>
<th>Twin-chamber type</th>
<th>Cassette type</th>
<th>Shuttle type</th>
<th>General purpose type</th>
<th>Micro joining type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representa- tive model</td>
<td>EBM-GB20C-0500</td>
<td>EBM-GB20C-2500</td>
<td>EBM-GB20C-0500</td>
<td>EBM-GB20C-2500</td>
<td>EBM-GB20C-1000</td>
<td>EBM-GB20C-1500</td>
</tr>
<tr>
<td>Workspace dimensions (mm)</td>
<td>rod diameter: 150</td>
<td>rod diameter: 150</td>
<td>rod diameter: 150</td>
<td>rod diameter: 150</td>
<td>rod diameter: 150</td>
<td>rod diameter: 150</td>
</tr>
<tr>
<td></td>
<td>face: 150</td>
<td>face: 150</td>
<td>face: 150</td>
<td>face: 150</td>
<td>face: 150</td>
<td>face: 150</td>
</tr>
<tr>
<td></td>
<td>height: 300</td>
<td>height: 300</td>
<td>height: 300</td>
<td>height: 300</td>
<td>height: 300</td>
<td>height: 300</td>
</tr>
<tr>
<td>Example of cycle time</td>
<td>20 sec</td>
<td>20 sec</td>
<td>10 sec</td>
<td>15 sec</td>
<td>30 sec</td>
<td>20 sec</td>
</tr>
<tr>
<td>Example of cycle time</td>
<td>60,000 pieces</td>
<td>57,000 pieces</td>
<td>74,000 pieces</td>
<td>69,000 pieces</td>
<td>4,000 pieces</td>
<td>1,000 pieces</td>
</tr>
</tbody>
</table>

*1: This represents a rough indication, based on 0.2 detection and 20 hours of operation at 64% efficiency.

Introduction of the Processing Center

Beam Technology Development Center

The Center offers services relating to advanced processing technologies based on electron beams in order to meet the sophisticated needs of our customers.

Sample manufacturing

All aspects of electron beam processing, including welding and surface modification, can be carried out. Selection of the optimum processing machine and establishing the optimum manufacturing process prior to installation of new equipment, not to mention studying the configuration and materials to be worked on, are of prime importance. We are ready to take on any challenge to create a processing system that others may consider impossible.

Exhibition and training school

Applications of the state-of-the-art electron beam and machine samples are exhibited. Customers are invited to inspect them at any time during business hours. Also, certain training courses are held periodically for specific training in machine operation.

Technological development

Technological development is supported by the comprehensive capabilities of Mitsubishi Electric. These include the development of processing software, hardware, and system development. We will continue to pursue the ultimate capabilities of beam processing and make unremitting efforts in technological development and innovation.

Consulting

Professional engineers are available for consultation on device selection and the application of this technology. These engineers have extensive experience in processing technologies such as welding and surfacing, and are experts in the applications of electron beams. They can look at situations from the standpoint of the user. Also, these professional engineers are available for technical seminars.

TADA ELECTRIC CO., LTD.

INDUSTRIAL APPARATUS WORKS

1-1, Tsuchiyu, Higashi-ku, Amagasaki City, Hyogo Prefecture 660-0011, Japan

Mitsubishi Electric Corporation Ramb Works

TADA Electric Co., Ltd. Applied Machinery Factory

Beam Technology Development Center (LT&D R&D 1F)

Tel: +81-6-6497-4138 Fax: +81-6-6497-9384

[From Kanazawa International Airport to TADA Electric]

Kanazawa International Airport

65 min. by car (Kanazawa City)

JR Amagasaki Station

20 min. by taxi

TADA ELECTRIC CO., LTD.
Safety Warning
Please be sure to read the instruction manual prior to use,
to ensure proper use of the products listed in this catalog.