INDUCTOTHERM GROUP

Electromagnetic Cold Crucible

CONSARC

EMCC History

Electromagnetic Cold Crucible (EMCC) is a process of melting metals in a segmented water-cooled copper crucible while under vacuum or controlled atmosphere using an induction coil to heat the melt.

EMCC furnace at manufacturing facility in Rancocas, NJ

In 1985, Consarc entered into an agreement with the company that patented the Electromagnetic Cold Crucible (EMCC) technology for reactive metals to be the exclusive worldwide licensee to promote the EMCC Technology. Since that time Consarc has continuously strived to improve, develop and refine the EMCC Technology to increase its efficiency. Consarc has pioneered new manufacturing techniques for EMCC crucibles and as a result have increased the crucible life by orders of magnitude. Our early collaboration with the patent holder and relationship with Inductotherm Group helped us develop power supplies specifically suited for the EMCC process and positions us as the most experienced resource for ElectroMagnetic Cold Crucible equipment. The original patent holder alone has claimed to have cast more than 3000 different alloys.

NREL, the National Renewable Energy Laboratory, in Golden, Colorado, first applied the EMCC process to semi-continuous silicon ingot casting in 1985. Although the EMCC process has not caught on in the US, it has been developed by private corporations in Japan and Europe.

In 2009, Consarc embarked on a multi-million dollar project to develop the next generation of commercially available EMCC furnaces. Consarc's EMCC furnace will incorporate our 25+ years of EMCC technology for reactive metals "Know How" to EMCC casting of multicrystalline silicon ingots. The new commercially available EMCC furnace will include many patent pending technologies that will increase the production rate of the furnace while increasing the quality and efficiency of the multicrystalline silicon ingot.

The EMCC process of casting multicrystalline ingots has benefits over that of traditional directional solidification casting processes.The EMCC process utilizes less energy during the casting process compared to the traditional solidification casting process. The purity level of the silicon ingot in the EMCC process is extremely high due to the “container less” casting of the silicon in the water cooled copper crucible. The water cooled copper crucible is reusable, thus eliminating the need to constantly supply costly consumable quartz solar crucibles. The EMCC process has a higher throughput and thus lower production cost in producing multicrystalline silicon ingots compared to that of the traditional directional solidification casting process.

Consarc’s standard EMCC production furnace will produce a 3,000 kg, 510 mm x 510 mm x 5000 mm long multicrystalline silicon ingot in approximately 72 hours; a current state of the art traditional directional solidification casting furnace will typically cast a 625 kg ingot in the same cycle time.

Consarc will also offer a modified version of our EMCC furnace to customers interested in refining solar grade silicon. Consarc’s EMR (ElectroMagnetic Refining) furnace will offer semi-continuous zone refining of silicon at an even higher production rate than that observed in our EMCC furnace.

Molten Silicon in EMCC Crucible

EMCC
The Process

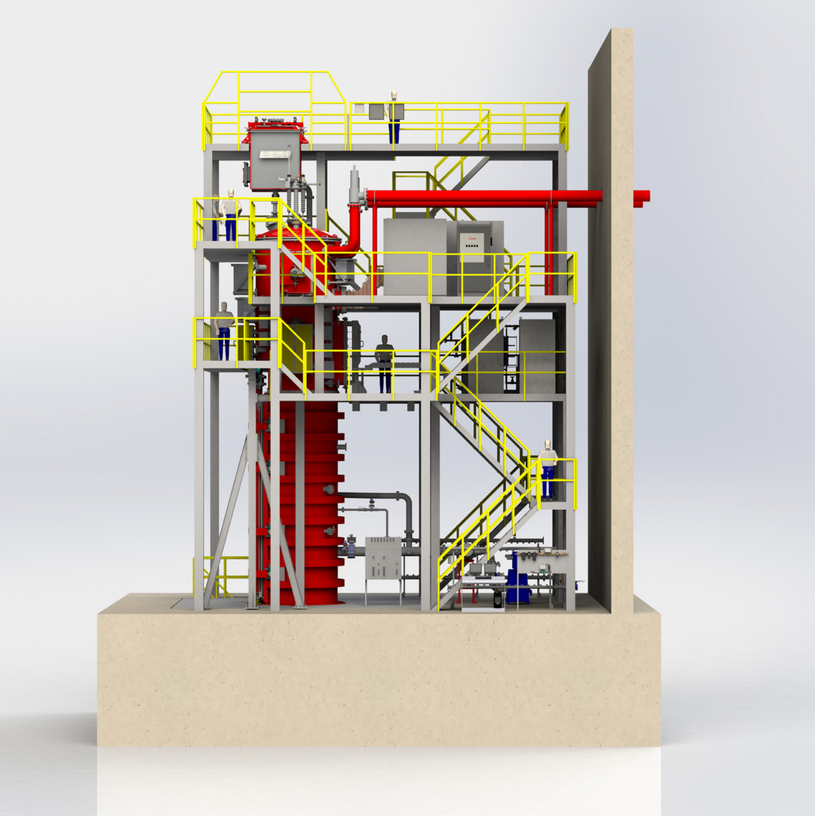
The development of Electromagnetic Cold Crucible (EMCC) furnace technology has enabled the production multicrystalline silicon ingots at a fraction of the cost of traditional Directional Solidification (DS) furnaces.

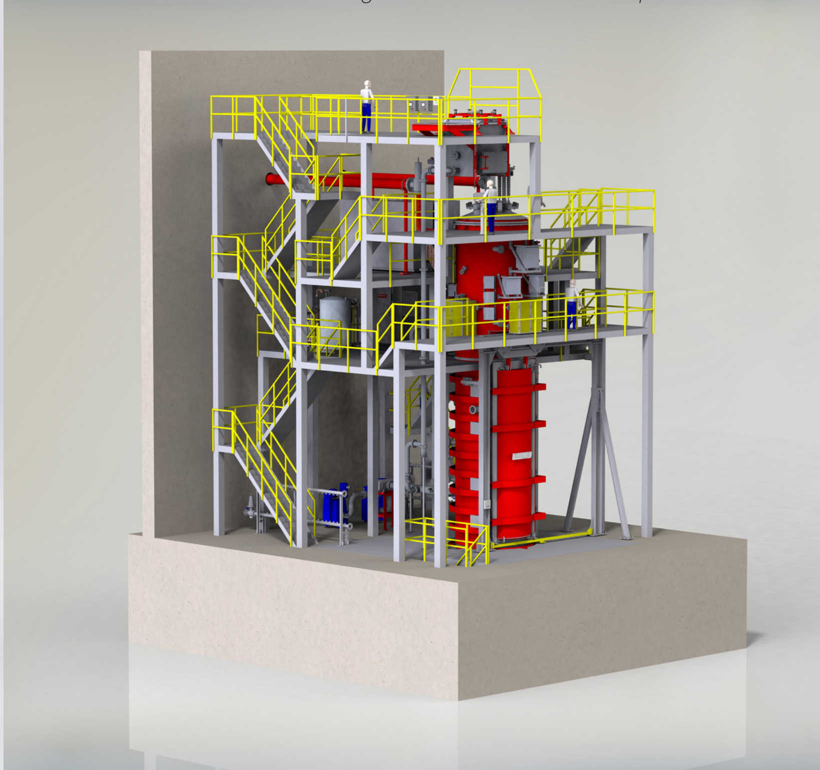
EMCC is an innovative process utilizing a segmented water-cooled copper crucible for refractory-free induction melting while under vacuum or controlled atmosphere. Melting in a water-cooled copper crucible eliminates the possibility of contamination from the fused silica solar crucible.

The copper crucible is made up of water-cooled segments or "fingers." The magnetic field produced by the coil, in effect, passes through the crucible to induce heat into the silicon. The magnetic field also intensely stirs the liquid pool and promotes a very homogeneous melt.

Since 1985, Consarc has continuously strived to improve, develop and refine the EMCC technology to increase its efficiency. We developed correlations between materials melted and power levels, frequencies and crucible diameters. Consarc has pioneered new manufacturing techniques for EMCC crucibles, and as a result has increased crucible life by orders of magnitude.

Renderings of EMCC furnace and superstructure





Advantages

The Electromagnetic Cold Crucible has several distinct advantages when compared to other sillicon ingot processing technologies:

NON-CONSUMABLE CRUCIBLE DESIGN

Consarc's water-cooled segmented copper crucible is designed for multiple heats compared to the one time use of a fused silica solar crucible in a traditional DS furnace. Another major advantage of the EMCC furnace is that the silicon melt is levitated off the water-cooled walls of the crucible, thus avoiding contamination of the molten silicon.

INCREASED PRODUCTION RATE

Typical growth rate of silicon ingots in a traditional DS furnace is 10-20 mm/hr. The EMCC growth rate is greater than 70 mm/hr depending on the withdrawal speed. Another advantage of the EMCC furnace is the increased useable yield from the silicon ingot compared to the average yield achieved in a traditional DS furnace.

PROCESS SAVINGS

Reduced Capital Cost
The EMCC furnace will displace a number of traditional DS furnaces; savings will be achieved with a reduction in factory space and high equipment consumption.

Reduced Operational Cost

- Less personnel required to operate
- Shorter cycle times
- Crucible is reusable

Silicon Ingot produced in EMCC

Solutions at every step

Primary Melting

Vacuum Induction Melting (VIM) is the first step in creating metals used in the most demanding applications. A VIM furnace incorporates an induction furnace within a vacuum chamber in order to prevent oxidation of volatile elements during the melting and refining stages. The end result of the process is a high purity metal with a homogenous chemical composition for use in secondary processing. Once molten and fully refined, the molten metal is passed through a preheated tundish for a final refinement before entering into ingots for further processing.

Masteralloy Vacuum Induction Melting Furnace (VIM)

Electrode Vacuum Induction Melting Furnace (VIM)

Secondary Processing

Remelting and casting are secondary melting processes used to further refine and improve the quality of materials produced from primary melting. During the remelting processes, a metal alloy ingot is melted in a controlled atmosphere environment to remove impurities and/or improve the macro and microstructure of the ingot or cast part, depending on the final application. The hallmark of secondary melting is not the melting but rather the controlled solidification which is what gives the final product its refined structure for use in high-temperature and high-stress applications.

Electroslag Remelting Furnace (ESR)

Vacuum Arc Remelting Furnace (VAR)

Vacuum Precision Investment Casting Furnace (VPIC)

Thermal Processing

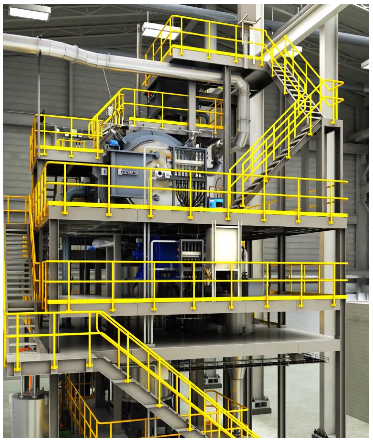
Vacuum Aluminum Brazing (VAB) is a specialized process used to join aluminum components using a brazing alloy in a vacuum environment. Brazing is commonly used to join metal parts that are difficult or impossible to weld using traditional welding techniques. Other thermal processing options are also available from Consarc, designed to fit customers' specific process needs.

Vacuum Aluminum Brazing Furnace (VAB)

Vacuum Heat Treat Furnace (VHT)

Specialized Melting

Consarc offers a wide range of additional melting options. Inert Gas Atomization furnaces are used to produce metal powders with high purity and controlled particle size distribution. Vacuum Cap furnaces are versatile units capable of vacuum degassing and controlled-atmosphere melting operations.



Vacuum Inert Gas Atomization Furnace (VIGA)

Vacuum Cap Furnace (VCAP)

ONE SIZE DOES NOT FIT ALL

Considering a stock furnace option that doesn't meet your exact needs? Why not consider a custom designed Consarc furnace?

Our team of experts works with you to create tailored solutions that fit your unique requirements. We don't believe in a one-size-fits-all approach - every project is different, and we take the time to understand your specific needs before designing a furnace that meets them perfectly.

Our commitment to collaboration and flexibility set us apart from other furnace manufacturers. You'll have input every step of the way, ensuring that the final product is exactly what you need. Plus, our flexible approach means that we can adapt to changes and make adjustments as needed.

Experience the difference a custom Consarc furnace can make. Get in touch with us today!

CONSARC
An Inductotherm Group Company

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ABOUT CONSARC

For more than 60 years, Consarc Corporation (USA) and Consarc Engineering Ltd (UK) have been designing vacuum induction furnaces and engineering solutions for the world's most advanced materials. We believe in a partnership approach that is present through furnace design, testing, delivery, and comissioning, but it doesn't stop there. Consarc offers after-sales support for troubleshooting, process optimization, and spare parts.

In addition to a field engineering team, Consarc has a global technology team dedicated to advancing furnace technologies and optimizing machine performance. Our 'tech team' staff have far-reaching backgrounds in research and production of various materials, processes, and processing equipment. Many services are offered including full Technology Packages, melt profile development, process optimization, operator training, and metallurgical consulting.

In a world where everyone seems to be looking for a quick fix or an off-the-shelf solution, we believe that there's tremendous value in taking the time to do things right. Contact us today to learn more about our solutions and how they can benefit your business.

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