

## **A Real-Time Measurement System for In-Situ Ingot Quality Evaluation During Vacuum Arc Remelting**

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### **ABSTRACT**

Utilizing magnetic field flux measurements to sense arc conditions during vacuum arc remelting provides a pathway for a real-time measurement system capable of determining deleterious operating conditions that lead to ingot product quality concerns. Here we present the theoretical background for performing these measurements and provide indicative results during operation, including identification of various deleterious operating conditions, some of which are identifiable with the current state-of-art measurements and some that are not. Measurement results will be presented demonstrating the efficacy of the measurement system, including rapid identification of constricted arcs, glows, and shelf fall-in. We will also provide evidence of how these measurements relate to ingot quality and how they can be utilized as a durable record of product quality.

Keywords: Arc Position Sensing, Arc Dynamics, Constricted Arcs, Glows, Side Arcs

### **INTRODUCTION**

Vacuum Arc Remelting (VAR) is a widely used process for the remelting and casting of specialty alloys and, in particular, those hard to make alloys that are susceptible to segregation (Ni-based super alloys) and/or are reactive (e.g., titanium). Here, the material to be remelted is suspended from the ram (Figure 1), becoming an electrode, and placed under a vacuum. A DC current is applied through the electrode and an electric arc is initiated between the electrode (the material to be refined) and the crucible. This arc, and its associated cathode spots, provide the energy for heating and melting of the electrode material while the overall process provides an environment for uniform solidification over the entire length of the ingot, thus providing product consistency and quality throughout.