



REAL-TIME THERMAL CONTROL & DYNAMIC QUALITY MANAGEMENT SYSTEM

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HIGHLIGHTS

- End-to-End Real-Time Closed-Loop Control
- Multi-Coolant Spray Stage Architecture
- AI-Powered Predictive Core

OPPORTUNITY

In welding and additive manufacturing (AM), excessive heat accumulation and uncontrolled thermal gradients often result in significant microstructural defects, geometric distortions, and reduced mechanical performance. Traditional post-process inspections and static cooling methods do not provide real-time dynamic interventions. To address this critical industrial challenge, researchers at the University of Alberta have developed a comprehensive real-time system that actively monitors, predicts, and controls thermal and process variables during manufacturing. Researchers have built and tested a fully functional prototype in a laboratory setting. This solution offers:

- **Dynamic Thermal Control:** Actively regulates dynamic process variables, including global cooling rate, melt pool cooling rate, and interpass temperature to maintain targeted mechanical and microstructural properties.
- **Improved Safety:** Non-flammable and free of the harsh chemical odors (e.g., ethyl ether) found in standard adhesives.
- **Adaptive Thermal Management System:** Integrates a dedicated cooling and heating stage that features specialized spray nozzles capable of using liquid nitrogen (LN₂), water, or refrigerated gases to prevent heat buildup and enhance heat transfer efficiency.
- **AI-Driven Predictive Architecture:** Fuses multi-sensor inputs into artificial intelligence models that predict thermal dynamic behavior and execute automated real-time adjustments



COMPETITIVE ADVANTAGE

- **Enhanced Throughput & Productivity:** Speeds up manufacturing cycles by increasing heat transferability.
- **Multi-Modal Sensor Fusion:** Combines pyrometers, IR thermal imaging, and thermocouples to provide full visibility into surface temperatures and dynamic thermal fields.
- **In-Situ Defect Elimination:** Shifts quality control from reactive post-inspection to proactive, automated closed-loop intervention, locking in structural tolerances and material phase stability before solidifying.

IP STATUS

- Patent pending

INVENTOR

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MORE INFORMATION

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