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# Inline sensor technology for robotic glass melting

Hansjörg Bornhöft<sup>\*†1</sup>, Shravya Gogula<sup>1</sup>, and Joachim Deubener<sup>1</sup>

<sup>1</sup>Institute of Non-Metallic Materials; Clausthal University of Technology – Germany

## Abstract

Advanced inline sensor technology was developed for a robotic glass melting system to monitor and control glass melting from the raw materials to the casting process to ensure safe operation. At the heart of the melting operation was a CCD camera setup that enables inline image analyses to distinguish between granular, foam (with granular particles), and clear melt stages. Therefore, a machine learning (ML) tool was developed and trained to autonomously identify these melting stages and to minimise melting times. The commands for the interaction between the ML image analysis tool and the robot control programme were sent via the transmission control protocol/internet protocol (TCP-IP). After batching, the melt enters the fining process with a temperature increase and the final casting of the melt. Castability was controlled by an automatic inline detection system based on laser reflection from the melt surface. After casting the molten glass, the entire set of parameters was stored in the form of key-value pairs and arrays in a human-readable text using the open standard file format JSON. The work is part of the joint research "GlasDigital: Data-driven workflow for accelerated exploration of glass" in Germany.

**Keywords:** autonomous glass melting, modeling, digital twin

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<sup>\*</sup>Speaker

<sup>†</sup>Corresponding author: [hansjoerg.bornhoeft@tu-clausthal.de](mailto:hansjoerg.bornhoeft@tu-clausthal.de)