FREQUENCY RESPONSE OF A MOLTEN METAL PUDDLE IN PLANAR FLOW CASTING

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Planar flow spin casting (PFSC) is a single stage rapid solidification technique for producing thin metal sheets or ribbons. Liquid metal is forced through a nozzle into a narrow planar gap where a puddle (similar to a bead in coating systems), constrained by surface tension, is formed. Upon contacting a rotating wheel, the metal freezes and a ribbon is spun off. PFSC has not been widely commercialized due to poor product surface quality. Our experimental casting machine typically operates with a 1mm gap between the nozzle and substrate and produces aluminum-silicon ribbons at 10m/s with approximately 0.15mm thickness. We focus here on the dynamics of the liquid metal puddle and its effect on the ribbon quality.

The puddle is subjected to a variety of disturbances, which are examined by both experimental and theoretical means. Displacements of the puddle menisci are captured using high-speed video and analyzed for frequency content. The primary frequency component can be directly related to the out-of-roundness of the wheel. A secondary frequency is identified as small-scale motions of the upstream and downstream menisci, which agree with observations of a novel cross-stream surface defect in the ribbon (~1000Hz). A macroscopic mass and energy balance is used to examine the dynamic response of the puddle and to gain insights into the source of the observed cross-stream defect.