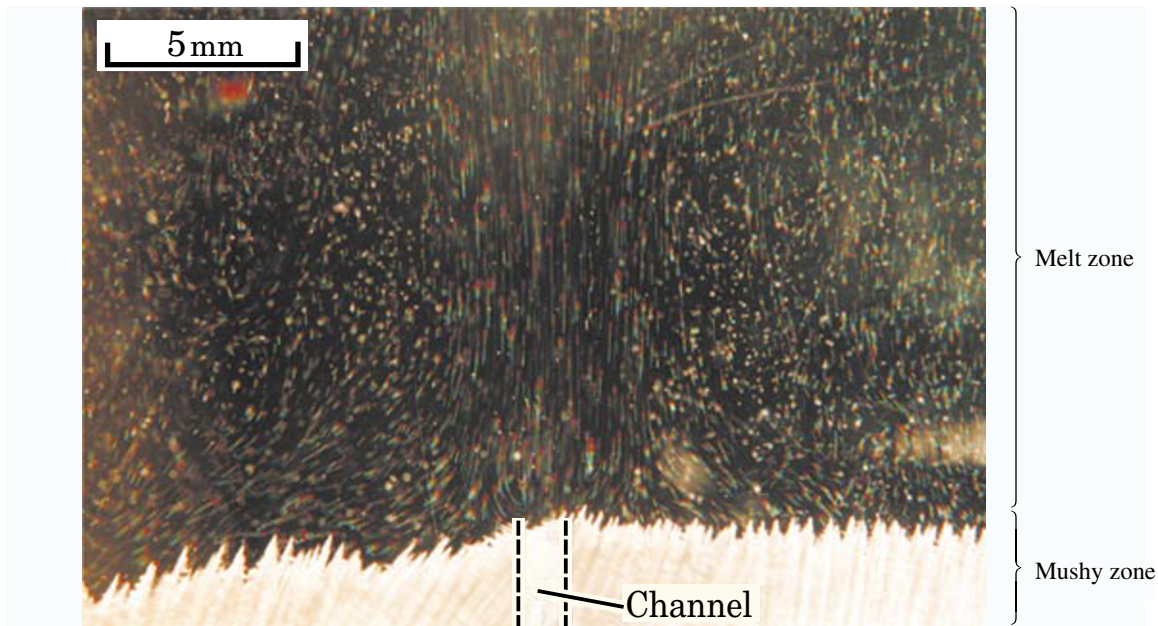


6. The Structure of Plumes Generated in Unidirectional Solidification Processes

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In the unidirectional solidification process of binary metallic alloys from a melt, several channels are formed in localized regions of the mushy layer composed of solid dendritic crystals with liquid in the interstitial spaces, known as freckles leading to the defects of materials. The origin of freckles is related to the onset of plume convection in the mushy zone*. The structure of plume convection emanating from channels in a transparent $\text{NH}_4\text{Cl-H}_2\text{O}$ system analogous to metallic alloy system is visualized by a sequential three color light sheet method which identifies upward and downward flows in the melt. A typical observation after 60min from the start of solidification experiment of a 27wt% of solution is shown on the figure. The flow direction is from red to blue line in each particle path during the exposure time, and thus the plume is found to consist of the upward flow enveloped in the downward flow, which has not been known previously. The central upward flow near the channel exit ranges from 2.6 to 3.8 mm/s during solidification.

* Nishimura, T. and Wakamatsu, M. (1998): Natural convection suppression and crystal growth during unidirectional solidification of a binary system, *Trans JSME, Ser. B*, 64, pp.1155-1160.