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Temperature Measurement during High-Rate Cooling of Metallic Melts

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In order to measure the behaviour of metallic liquid layers during rapid thermal transition, it is necessary to use detectors with high sensitivities and low response times. Film thermocouples produced by vapour deposition are in spite of their satisfactory response times not suitable, due to inter al. their insufficient sensitivity and low maximum operating temperature. Connecting the thermocouple parts with the molten metal itself causes inhomogeneities which lead to errors if the connection is in a thermal gradient field. A further disadvantage is that the voltages obtained with such connections can never be correlated to temperatures.

Measurement of the radiation emitted by a rapidly cooling liquid layer produced with the aid of a shock tube which is at the point of transition from the liquid to the solid phase with a photomultiplier arrangement on the other hand makes it possible to investigate metal layer behaviour in this condition with a sufficient degree of sensitivity and speed. Use of this process allowed supercooling to be proved for the system Cu-Ni. The question of whether further thermal pulses of far smaller amplitude observed after transition from the liquid to the solid phase were the result of exothermic crystal growth processes could be resolved by analysis of the first differential quotient of the radiation curve.

The cooling rates of the molten metal layers were highest for ~ 20 μm thick Al layers after preceding great overheating of the melt in a shock tube ($\dot{T} \approx 1.5 \cdot 10^6$ grd·sec^{-1}). Lower rates of cooling were measured for Cu layers of approximately the same thickness; further considerable reduction of the rate of cooling was achieved on addition of as little as 5 weight % Ni.