ON THE INCORPORATION OF METALLIC AND NON-METALLIC SOLID PARTICLES INTO MOLTEN METALS

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The influence of solid particles on the viscosity of liquid metals is of great interest for the production of metal matrix composites and metal foams as well as for metal casting [1, 2]. In order to study the viscosity behaviour of metal melts with suspended solid particles in detail, samples with a defined amount of solid particles are needed. Therefore different incorporation techniques have been tested for their ability to introduce solid particles into liquid metals.
For the proof of principle different combinations of metals and solid particles have been used for these experiments. Both pure metals such as Sn and Ga and low melting alloys such as Wood's metal and the eutectic of Ga, In and Sn were put to use. Apart from metallic particles ceramic ones have been used as solid phase.
Firstly, the suitability of magnetic stirring for the incorporation of solid particles into metal melts has been examined. A combination of rotating and travelling magnetic field was used to produce an intensive contact between the liquid metal and the solid particles [3]. Secondly, mechanical stirring with a laboratory agitator has been scrutinized under different ambient conditions. The mixing process was carried out in an inert gas atmosphere. Furthermore an inorganic layer was used to avoid oxidation of the liquid metal surface during mechanical stirring. Thirdly, laser melt injection has been used. In this process the surface of the solid metal was local molten by a laser beam and solid particles were injected into the melt pool through a nozzle [4].
To check the success of particle incorporation the solid metal samples have been frozen with liquid nitrogen and broken apart. The fracture surfaces were analysed with optical and electron microscopes. Successful particle incorporation has been observed in the case of mechanical stirring with an inorganic protection layer and by using the process of laser melt injection. In contrast to the mechanical stirring with an inorganic layer the process of laser melt injection enables the introduction of undefined amounts of solid particles only.
Metallic particles could be introduced and dispersed homogeneously in liquid metals much better then the ceramic ones. In the case of ceramic particles a separate dispersion step subsequent to the incorporation step is needed to produce a homogeneous particle distribution inside the liquid metal. For this case an ultrasonic device could be used.

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