STATIC, DYNAMIC AND ISO-STRUCTURAL YIELD-STRESS IN SEMI SOLID ALLOYS - EXPERIMENTS AND MODELS

M.A. Brinks[1], S. Harboe[1], M. Modigell[1], A. Pola[2]

1 - RWTH Aachen University, Aachener Verfahrenstechnik AVT.MVT, Aachen, Germany
2 - University of Brescia, Mechanical and Industrial Engineering Department, Brescia, Italy

martin.brinks@avt.rwth-aachen.de

At present it is discussed intensively if it is necessary to consider yield stress in the rheological models of semi solid metal alloys. Some authors claim that the yield stress is very high and significantly influences the flow behaviour of semi solid alloys, while other authors suggest that the yield stress is negligible during the flow of the slurry into a cavity. It has been pointed out that the yield stress is a time dependent property, and that it is necessary to distinguish between the dynamic and the static yield stress. The dynamic yield stress increases with time due to the formation of an internal structure of the material. After sufficient time the maximum value, the static yield stress, is reached which corresponds to the final structure.
In addition to this the existence of an iso-structural yield stress has to be considered. The iso-structural yield stress is related with the structure of the material during shearing and which should be identified immediately after shearing. Due to the resolution of the measuring device used it is not possible to measure the iso-structural yield stress directly.
The build-up of an internal structure has been measured by means of shear stress ramp and oscillation experiments. Shear stress ramp experiments with varying resting times between the shearing and the beginning of the ramp have been performed to measure the yield stress. This leads to an equation which describes the rate of change of the dynamic yield stress. Extrapolation of this equation to resting time zero yields a value for the iso-structural yield stress. Oscillation experiments show that the elastic nature of the material increases with resting time.
The described experiments have been performed with samples of varying particle sizes and solid content. The particle size can be adjusted by the duration of the preshearing before the actual experiment. The solid content can be set by keeping the sample at a specific temperature. The particle size can be analysed by metallographic inspection of samples which have been quenched with liquid nitrogen. By means of these experiments equations were derived for the dependence of the yield stress on the particle size and the solid content.