Development of the modeling strategy for the steel deformation in semi-solid state - thermal model for macro scale analysis

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ABSTRACT

The work presents the part of the project leading to development of the modeling strategy for the steel deformation in semi-solid state. The main core of the modeling strategy is developed by author, a special simulation system called DEFFEM [1], which consist of several mathematical models. Developed tools are dedicated to support experimental procedures conducted by using Gleeble 3800 thermo-mechanical simulator as well as Zwick Z250 machine (at lower temperatures) [2]. The essential aim of the simulation was the reconstruction (on a small sample) the changes of temperature and stress for material which was subjected to both deformation and solidification. The connection of the theoretical part with experimental part give a new unique approach to modeling of steel deformation at extra-high temperatures as well as in semi-solid state. In the current paper the mainly attention was paid on presenting a thermal model for macro scale analysis. The investigations presented in the current work has shown, that temperature distribution inside the controlled semi-solid volume is strongly heterogeneous and non-uniform (Fig.1).

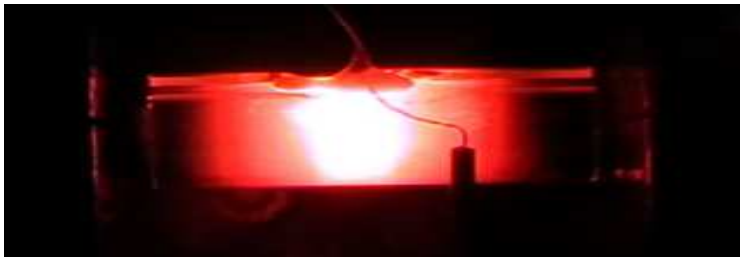

Fig.1. Melting process of the sample and visible no-uniform temperature distribution

It is good practice to test materials in isothermal conditions. Unfortunately, this is not possible for semi-solid steel. Nevertheless, the condition should be as close to isothermal as possible due to the very high sensitivity of material rheology to even small variations of temperature. The basic reason for uneven temperature distribution inside the sample body on the Gleeble simulator is the contact with cold/warm copper handles [2]. Example results of the developed system in application to the testing procedures are presented as well.

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