Structural Mechanisms of Dilatometric Processes in the Al -Zn Alloys

Natalia Minina [C, S], Vyacheslav Yermishkin and Ivan Nivikov
Baikov Institute of Metallurgy and Material's Science of the Russian Academy of Sciences, Moscow, Russia

Temperature actions on metals and alloys, as a rule, stimulate the development of the irreversible processes of their structural evolution. Dilatometric hysteresis can be considered as the manifestation of the total effect of such processes development. It is of interest to explain the nature of the separate mechanisms, which make their contribution to the temperature dependences of total size effects during the heating, cooling of metallic alloys and etc. For this it is necessary to find from the dilatometric curves the temperature intervals of the characteristic kinetic special features, which are reflected in the form of these curves, then to make the analytic description of their separate stages and to estimate the thermal activation parameters of the processes, which control their development. It should be noted that many elementary processes, which can be the reasons for a change in the sizes of samples under investigation, are known: the thermal expansion of material, phase and structural transformations, viscous flow under its own weight, creep, stimulated by internal stresses. Each of these processes has their special features, which are inevitably reflected in the form of dilatometric curves in the specific temperature intervals. In view of the synergetic nature of their interrelation, there appears the need to attract additional information sources for the analysis of these processes. In the present investigation in parallel with conducting dilatometric studies of Al-15 %Zn alloy in the same samples, the photometric analysis of the structure of their surface was achieved before and after temperature actions, employing the original procedure developed by the authors. Thermal activation analysis was conducted within I.I. Novikov's theoretical ideas, presented in the monograph "Phase transitions and critical points between solid-state phases". As the physical variable, which determines the structural state of the material being investigated, the effective time of the process of the deformation of sample ($t_{\diamond}$) is examined with its heating in the working cell of dilatometer. This parameter was written in the form, previously used by D. Dorn for the analysis of high-temperature creep: $t_{\diamond}=t\cdot\exp(-\Delta G/kT)$, where: t - the chronometric time of process, ΔG - a change of the Gibbs free energy in the investigated process, k - the Boltzmann constant, T - the absolute temperature, at which the process was achieved. The thermal activation parameters of the investigated processes were defined both by the kinetics of a change in the material, thermal deformations, and by the kinetic characteristics of the material structural evolution from the photometric measurements. Identity conditions of the activation energies determined from both methods were revealed in this case.