The mechanism and kinetics of processes of precipitation from supersaturated solid solutions were studied in [1-7].

It has been noted frequently that changes in the number of lattice defects, for example by preliminary deformation of the solid solution or deformation during aging, affect the precipitation of excess phases both in the initial and later stages of transformation.

The purpose of this work was to study the kinetics and mechanism of certain aging processes in the SAV-1 alloy (Al-Mg-Si) at 110°C and also the effect of deformation before aging and during aging on the kinetics and mechanism of the processes. The investigation was conducted with an alloy naturally aged at room temperature 20 months after quenching in water from 530°C (holding 2 h). The chemical composition of the alloy was 0.78% Mg, 0.88% Si, 0.015% Mn, 0.23% Fe, 0.015% Cu, and 0.0035% Ti.

Aging under stress was conducted in tension in the AIMA-5 apparatus to test the long-term strength at 110°C at stresses of 9.5, 13, 15, and 17 kg/mm². The samples were cylinders 10±0.03 mm in diameter. Simultaneous tests were made with naturally aged (NA) samples in the original condition and after 3 and 7% deformation in tension. The samples were then subjected to mechanical tests in the IM-4R machine and hardness tests. The lattice constants of the α-solid solution were measured by the (200) and (331) lines in the KROS camera with CoKα radiation with wavelengths \( \lambda_{\alpha 1} = 1.7889 \, \text{Å} \) and \( \lambda_{\alpha 2} = 1.7927 \, \text{Å} \). The Wulff-

![Fig. 1. Variation of mechanical properties of SAV-1 alloy with aging time at 110°C. 1) Naturally aged; 2, 3, 4) aged under stresses of 13, 15, and 17 kg/mm²; 5, 6) naturally aged with preliminary deformation of 3 and 7%.

Translated from Metallovedenie i Termicheskaya Obrabotka Metallov, No. 10, pp. 33-37, October, 1968.
Fig. 2. Creep curve for SAV-1 alloy at 110°C with $\sigma = 17\text{ kg/mm}^2$.

Fig. 3. Variation of lattice constant of $\alpha$-solid solution of the SAV-1 alloy at 110°C. 1) Aged under stress of 9.5 kg/mm²; 2) aged without stress.

Bragg reflection was $\sim 81^\circ$ for (420) and $\sim 74^\circ$ for (331). The error in measuring the lattice constant by lines (420) and (331) did not exceed $\Delta a/a = 0.0008-0.001$. Annealed A0000 aluminum was used as a standard in determining the distance between the film and the sample.

The variation of the mechanical properties with the aging time at 110°C is shown in Fig. 1. The values of microhardness after aging at 110°C under stress $\sigma = 9.5 \text{ kg/mm}^2$ are given in Table 1.

With aging at 110°C the strength characteristics increase (hardness, nominal yield point) and the specific elongation decreases. After 2000 h at 110°C under stress of 9.5 kg/mm² the hardness increases from HB 74.6 (NA) to HB 122, the ultimate tensile strength from 24 to 28 kg/mm², and the nominal yield point from 17 to 24 kg/mm²; the specific elongation drops from 24 to 2%. Embrittlement is induced by the fine precipitates of silicon and acicular phases of the Mg$_2$Si type. The excess phases are precipitated in the body of the grains, boundaries, and subboundaries.

Comparison of the curves for samples aged under stress and without stress shows that the higher the stress applied during aging, the greater the hardening. Hardening is most intense during the first stage, corresponding to the initial section of the creep curve (Fig. 2). Hardening slows down during the second stage of creep. The ultimate tensile strength of samples aged under stresses of 13, 15, and 17 kg/mm² first increases, then changes little, and finally reaches lower values than for samples aged without stress. The ultimate tensile strength of samples aged under a stress of 17 kg/mm² decreases somewhat after the initial increase in the first stage of creep. This variation in the ultimate tensile strength of samples aged under stress may be due to the accumulation of submicrodefects in the process of creep, which can cause pores of submicroscopic cracks in the grain boundaries. The aging process is considerably accelerated by application of stress.

The intensification of aging processes in the initial stage under stress is due to an increase in the density of lattice defects. During the movement and interaction of high-mobility dislocations the dislocations are pinned and the density of low-mobility dislocations increases. As the electron microscopic examination showed, spherical and plate-like precipitates form preferentially on dislocations, and therefore an increase of low-mobility dislocation density promotes acceleration of precipitation processes. During steady-state creep, when high-mobility dislocations are pinned and can move only by means of diffusion, the dislocation density increases little and the rate of the aging process under stress differs little from the rate without stress, which can be seen from the slopes of the curves of hardness, nominal yield point, and specific elongation. The variation of the lattice constant of the $\alpha$-solid solution indicates more complete precipitation processes in the initial stage of aging under stress (Fig. 3).

It is well known that silicon and magnesium have opposite effects on the lattice constant of aluminum [8]: an increase of the silicon content of the solid solution decreases it, while an increase of the magnesium content increases it. Thus, the precipitation of silicon and magnesium from the supersaturated solid solution...