DYNAMICS OF DISLOCATIONS IN SOLID SOLUTIONS AT ALTERNATING STRESSES

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Within numerical methods, we study the dynamics of steady oscillations of a dislocation loop in the presence of weak pinning centers in its slip plane. The analysis is carried out for the zero effective frequency of forced oscillations in wide intervals of oscillation amplitudes and the normalized viscosity. We have established the critical value of the normalized viscosity such that the influence of the viscosity on the overcoming of weak pinning centers by a dislocation disappears when this value is exceeded. Mechanisms of the influence of the viscosity on the dynamics of dislocations at alternating stresses are studied. As the normalized viscosity decreases in an interval below its critical value, the magnitude of the jumps of a deformation on the hysteresis curve increases, and the separation stress of a repinned immovable dislocation decreases. It is shown that such an influence of the viscosity on the dynamics of dislocations is due to the inertial mechanism of overcoming of pinning centers by dislocations. We have studied the influence of the viscosity on the amplitude dependences of the internal friction and the elasticity modulus defect. The former is in good agreement with the established peculiarities of the dynamics of dislocations at the manifestation of the inertial mechanism.

1. Introduction

The dynamical behavior of dislocations affects strongly a state of the structure of crystalline solids which determines, in its turn, their plastic properties and the dissipation processes running in them. In this connection, regularities of the dynamics of dislocations are of importance at the prediction of and the control over many physical properties of crystals. In particular, it is necessary to comprehend the dislocation mechanisms of energy dissipation at the fabrication of materials for elastic oscillatory systems with low dissipation and at the development of highly damping materials [1]. Despite the almost half-century-history of studies of the dynamics of dislocations, both direct and indirect experimental methods aimed at the study of the dynamics of dislocations do not allow one to obtain the complete information about it. In this case, the comparison of the results of studies of the dynamics of dislocations which are got by different procedures meets, as a rule, a number of difficulties caused by the influence of the peculiarities of experimental conditions for a specific procedure on the dynamical behavior of dislocations. Therefore, the present work is devoted to the numerical analysis of the dynamics of dislocations.

At alternating stresses, the motion of a dislocation in the slip plane, which includes a great number of randomly located weak pinning centers formed by impurity atoms, is limited not only by a linear tension, but also by the stress fields of these centers. Under such conditions, the study of the dislocation hysteresis and relative contributions of the main mechanisms of energy dissipation (the interaction of dislocations with elementary excitations of the crystal lattice and with pinning centers) cannot be performed within the well-known string model [2, 3]. Later on, due to the complexity of the analytic derivation of quantitative results, the analysis was realized by numerical methods [4, 5]. However, it failed to cover a number of basically important aspects of the dynamics of the oscillatory motion of dislocations.

The purpose of the present work is the study of the dynamics of a dislocation loop by using numerical methods in wide intervals of variations of the amplitude of an external stress and the viscosity in the presence of pinning centers in the slip plane.

2. Description of the Model and a Method of Calculations

We study the dynamics of a dislocation loop with rigidly fixed ends in the presence of weak pinning centers in the slip plane. The coordinates of weak pinning centers were set by a generator of pseudorandom numbers. Deflections of dislocation segments remained always significantly less than their lengths, which is realized under the following condition: $F_m/C \ll 1$, where C is the linear tension of a dislocation, and F_m is the force of interaction of a weak pinning center with a dislocation. The analysis is carried on in the frame of the model described in [6] at the activationless separation of dislocations from pinning centers and the zero effective frequency of an external stress. While numerically solving the equation of the dynamics of a dislocation, we performed its normalization given in [5].

The normalization allows us to present the results in a more informative form and to significantly decrease the computation time. The formulas for the normalized coordinates and time are as follows:

$$\xi = (x/l_S)(F_m/2C)^{1/2},$$

$$\eta = (u/l_S)/(F_m/2C)^{1/2},$$

$$\theta = (t/l_S)(F_m/2A)^{1/2},$$

where ξ, x, and η, u are the dimensionless and ordinary coordinates along and across the dislocation loop line, respectively, l_S is the mean distance between pinning centers, A is the mass of a dislocation per unit length, θ and t are the dimensionless and ordinary times, respectively.

The equation of the dynamics of a dislocation in normalized coordinates has the form

$$\frac{1}{2}\frac{\partial^2\eta}{\partial\theta^2}+\gamma\frac{\partial\eta}{\partial\theta}-\frac{1}{2}\frac{\partial^2\eta}{\partial\xi^2} = S_0\sin\Omega\theta+\sum_{i=1}^{N}\Phi\Big(\frac{\xi-\xi_i}{\xi_0};\frac{\eta-\eta_i}{\eta_0}\Big), \quad (1)$$

where ξ_0 and η_0 are the normalized sizes of the region of interaction of a pinning center and a dislocation along the directions ξ and η, respectively;

$$\Phi\Big(\frac{\xi-\xi_i}{\xi_0};\frac{\eta-\eta_i}{\eta_0}\Big)$$

is the normalized force acting on a unit length of the dislocation from the side of a pinning center;

$$\Omega = \omega l_S(2A/F_m)^{1/2}$$

and

$$S_0 = (\sigma b l_S/(F_m)^{3/2})(2C)^{1/2}$$

are the normalized frequency and the amplitude of an external stress, respectively, ω and σ are the frequency and the amplitude of an external stress, b is the Burgers vector,

$$\gamma = (Bl_S)/(2AF_m)^{1/2}$$

is the normalized viscosity, and B is the coefficient of damping. The sum on the right-hand side of Eq.(1) takes the interaction of a dislocation and weak pinning centers into account. The intervals of variations of the normalized parameters of Eq.(1) were chosen with regard for the ranges of physical values of these parameters which are observed in various materials. The dislocation loop length l_N varies in the limits $10^{-6}-10^{-4}$ m, the ratio l_N/l_S changes from 10 to 150, and the size of the region of interaction of a pinning center and a dislocation is $10^{-8}-10^{-7}$ m. According to [7], we used the following characteristic values of physical parameters for the estimation of the normalized viscosity: $b = 3\cdot10^{-10}$ m, $C = 10^{-9}H$, $A = 10^{-15}$ kg·m^{-1}; the coefficient of damping varies in the interval $10^{-7}-10^{-4}$H · s· m^{-2} [8]. In this case, the values of γ for weak pinning centers with $F_m/C < 1$ for most materials are in the range $10^{-2}-10^{2}$. Just there, we have performed the analysis.

It is worth noting that, at the indicated ratios l_N/l_S and under the condition $F_m/C < 1$, the values of γ for such semiconductors as lead, indium, and niobium at low temperatures both in the normal and superconducting states belong to the above-indicated range. Thus, the dynamics of dislocations in these materials can be described within the given model and, moreover, can be experimentally studied, as it will be demonstrated below. The largest value of the normalized amplitude of an external stress S_0 was chosen such that the mean displacement of a dislocation loop from the equilibrium position turned out always significantly less than the loop length l_N.

In the frame of the mentioned model, we will consider the dynamical behavior of a dislocation loop in the process of its oscillation in wide intervals of the amplitude and the normalized viscosity, by using numerical methods.

We obtained some dependences which characterize the dynamics of dislocation loop:
– the time dependence of the shape of a dislocation loop at varios values of the amplitude of an external stress;

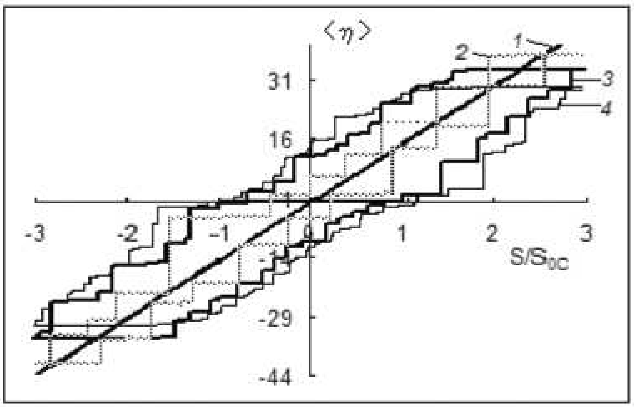


Fig. 1. Mean dislocation deformation $\langle\eta\rangle$ versus the normalized amplitude of an external stress (S/S_{SC}). *1* – in the absence of pinning centers in the slip plane of a dislocation at any values of γ; *2, 3, 4* – in the presence of pinning centers in the slip plane at $\gamma = 0.05$, $\gamma = 1.5$, and $\gamma \geq 2$, respectively

– the dependence of the mean dislocation deformation on the amplitude of an external stress;
– the time dependence of the power scattered by a dislocation loop.

In addition, we determine the amplitude dependences of the internal friction and the elasticity modulus defect. The method of calculations of these characteristics is given in [6].

3. Results and Their Discussion

We studied the dynamics of a dislocation loop at various values of the normalized viscosity γ in the interval of the amplitudes of normalized stresses $0 \leq S \leq 5S_{SC}$, where S_{SC} is the normalized critical amplitude of a stress, starting from which the separation of a dislocation loop from pinning centers becomes possible. The obtained dependences of the mean dislocation deformation $\langle\eta\rangle$ on the external stress S testify that the curve of a dislocation hysteresis loop $\langle\eta\rangle(S/S_{SC})$ has a jump-like character in the whole studied interval of amplitudes of an external stress and the normalized viscosity. A characteristic example of such dependences for a specific value of the amplitude of an external stress and several values of γ is given in Fig. 1.

The dependence $\langle\eta\rangle(S/S_{SC})$ in the form of a straight line segment (line *1* in Fig. 1) corresponds to the absence of pinning centers in the slip plane of a dislocation. In such a case, no influence of γ on the dependence $\langle\eta\rangle(S/S_{SC})$ is observed.

The analysis of the shape of a dislocation loop and the dependence of the power scattered by a dislocation on time $P(\theta)$ for various sections of the dependences $\langle\eta\rangle(S/S_{SC})$ testifies to the following. The dislocation deformation caused by a deflection of dislocation segments without the separation from pinning centers is negligible as compared with the total dislocation deformation. The contribution of the energy scattered by a dislocation during such a motion to the total energy scattered for the period of oscillatory motion is extremely small. Such a motion of a dislocation loop corresponds to horizontal sections on the dependences $\langle\eta\rangle(S/S_{SC})$. The dispersion of the energy of a dislocation occurs during the jump on the dependence $\langle\eta\rangle(S/S_{SC})$, when the separation of a dislocation from pinning centers, its motion, and the repinning on a new configuration of centers are observed. In the case where $\Omega \approx 0$, the jump duration in shares of the period was always extremely small. In this connection, the motion of a dislocation loop at the time moment of a jump corresponds to vertical segments on the dependences $\langle\eta\rangle(S/S_{SC})$. The comparison of the dependences $\langle\eta\rangle(S/S_{SC})$ obtained at different γ testifies to the existence of a critical value of $\gamma_c \approx 2$, starting from which the influence of γ on a dislocation hysteresis loop disappears completely (Fig. 1).

We note that, as γ increases at $\gamma \geq\, \geq \gamma_c$, the mean velocities of motion of a dislocation loop and its local segments continue to decrease. At the same time, the values of jumps on the dependence $\langle\eta\rangle(S/S_{SC})$, the values of stresses, at which the jumps occur, and the energy scattered by a dislocation in the course of each jump remain invariable. In the region $\gamma \leq \gamma_c$, differences in the dependences $\langle\eta\rangle(S/S_{SC})$ obtained at different values of γ can be explained in the following way. The mean value of a deformation jump increases, as γ decreases to $\gamma \approx 0.1$ (Fig. 1). At $\gamma \leq 0.1$, the value of $\langle\eta\rangle$ after each separation of a dislocation loop and the subsequent repinning of a dislocation is always close to that in the absence of pinning centers in the slip plane at the same external stresses. It is seen in Fig. 1 that points of the dependence $\langle\eta\rangle(S/S_{SC})$, which are obtained at $\gamma = 0.05$ and correspond to the termination of the jump, are located near the straight line, being a plot of $\langle\eta\rangle(S/S_{SC})$ in the absence of pinning centers. However, despite the fact that the change of γ at $\gamma < 0.1$ causes a change in the dependence $\langle\eta\rangle(S/S_{SC})$, the influence of γ on the mean jump of a deformation and on the energy scattered by a dislocation loop for the period is practically absent.

It follows from Fig. 1 that the influence of γ on the dependences $\langle\eta\rangle(S/S_{SC})$ at $\gamma \leq 2$ is revealed not only in a change of the jump of a deformation, but also in a change of the separation stress for a dislocation loop, at which the jump-like increase in the deformation begins.

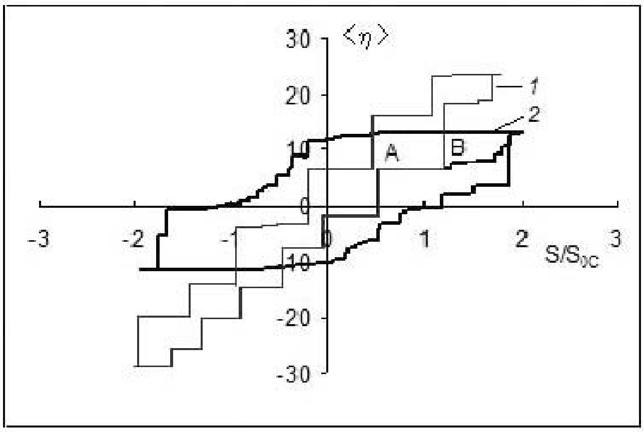
A decrease in the viscosity in the region $\gamma \leq \gamma_c$ leads to a monotonous decrease in the separation stress for a dislocation loop. For example, as γ decreases from 2 to 0.05, the quantity $(S - S^*)$, (where S is the separation stress with the subsequent jump of a deformation, and S^* is the stress which is necessary in order to attain the same value of $\langle\eta\rangle$, but in the absence of pinning centers) decreases almost twice. Such a character of the influence of γ on the quantity $(S - S^*)$ is determined by that the separation stress for a immovable dislocation loop depends on the value of γ, at which the dislocation moved earlier through the network of pinning centers up to the stop due to the repinning, rather than on the value of γ, at which the separation occurs.

In Fig. 2, we show the dependences $\langle\eta\rangle(S/S_{SC})$ for two fixed values of γ. Section AB on the dependence $\langle\eta\rangle(S/S_{SC})$ at $\gamma = 0.1$ (Fig. 2,*a*) corresponds to the state of a dislocation pinned on a certain configuration of centers. In this case, the change of γ in the whole interval of its values has no effect on the separation stress for a dislocation loop (for all γ, the separation occurs at stresses which correspond to point B).

The magnitude of the first jump of a deformation at point B at $\gamma \geq \gamma_c$ turned out comparable with those of the third and fourth jumps and was significantly less than that for the second one. It is seen that, after several jumps of a deformation, the dependence $\langle\eta\rangle(S/S_{SC})$ coincides completely with an analogous dependence obtained at $\gamma \geq \geq \gamma_c$. In a similar way, section AB in Fig. 2*b* corresponds to the pinned state of a dislocation loop after its previous oscillatory motion at $\gamma \geq \gamma_c$. The separation stress for such dislocation loop does not also depend on γ and is always observed at point B. It is seen from the figure that the hysteresis loop acquires the features characteristic of small values of γ already after the first jump of a deformation at point B at $\gamma = 0.05$.

Thus, the results testify to the absence of the influence of the viscosity on the separation stress for a pinned dislocation loop in the whole interval of stress amplitudes under study. In this case, the separation stress for a dislocation loop is determined by the value of the normalized viscosity, at which the dislocation loop moved before its stop due to the repinning.

The established character of the influence of the viscosity on the dynamics of a dislocation is related to one more peculiarity of the mutual positions of the dependences $\langle\eta\rangle(S/S_{SC})$ obtained at different values of γ. In Fig. 3, we present the dependences $\langle\eta\rangle(S/S_{SC})$ obtained at two values of γ for the amplitude of an external stress: close to S_{SC} (Fig. 3,*a*) and equal to $3S_{SC}$ (Fig. 3,*b*). The character of the mutual position of the dependences



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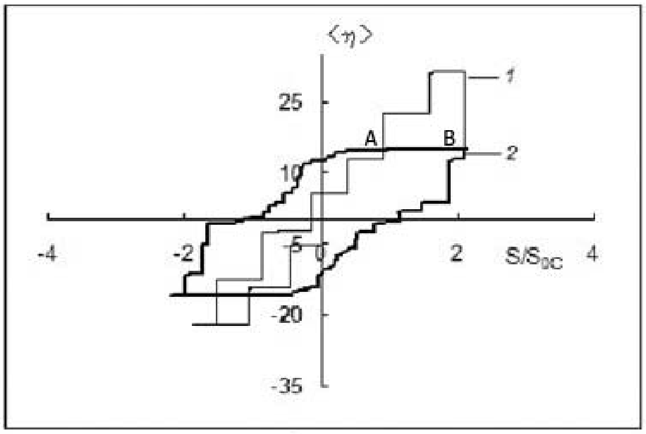

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Fig. 2. Dependences $\langle\eta\rangle(S/S_{SC})$ which illustrate the influence of the viscosity on the separation stress for an immovable dislocation loop at $\gamma = 0.1$ (lines *1*) and $\gamma \geq \gamma_c$ (lines *2*). In Fig. 2,*a*, section AB corresponds to the pinned state of a dislocation loop after its motion at γ =0.1, and section in Fig. 2,*b* corresponds to the pinned state of a dislocation loop after its motion at $\gamma \geq \gamma_c$. On sections AB, a change of γ on the whole interval under study has no effect on the separation stress for a dislocation loop

$\langle\eta\rangle(S/S_{SC})$ for the indicated values of γ is qualitatively different in the regions of small and large amplitudes of stresses. For large values of S ($S > 3S_{SC}$, Fig. 3,*b*), practically the entire hysteresis loop obtained at small values of γ is positioned inside the hysteresis loop obtained at $\gamma \geq \gamma_c$. In this case, as γ decreases from 2 to 0.1, the hysteresis loop area and, hence, the energy scattered for the period of oscillations decrease by several times. On the contrary, the hysteresis loop area and the energy scattered for the period increase by several times in Fig. 3,*a* at an analogous change of γ.

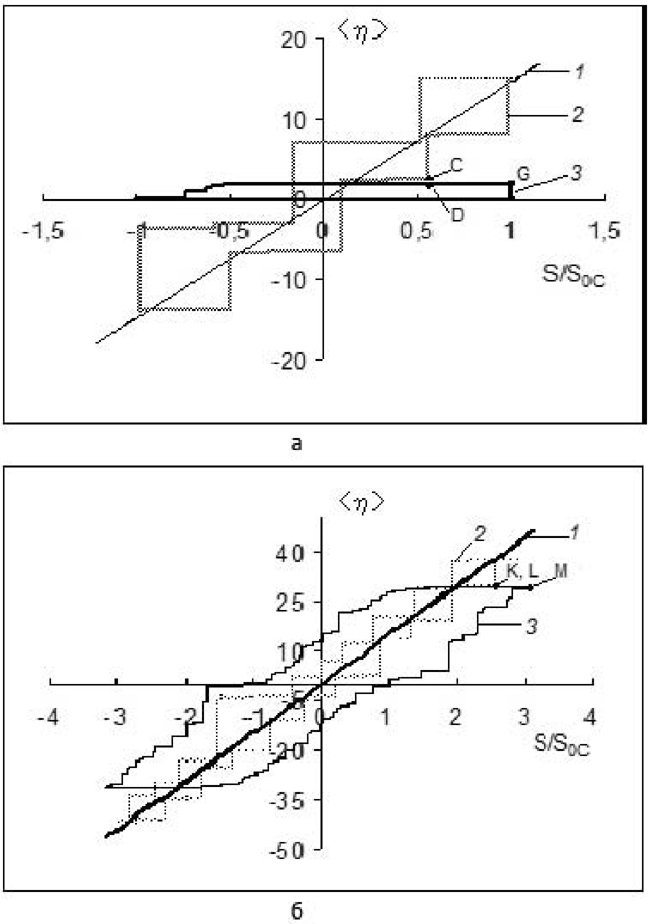

Fig. 3. Character of the influence of the viscosity on the dependence $\langle\eta\rangle(S/S_{SC})$ in the regions of small ($S/S_{SC} \approx 1$, Fig. 3,*a*) and large ($S/S_{SC} \approx 3$, Fig. 3,*b*) amplitudes of an external stress: in the absence of pinning centers in the slip plane (lines *1*); in the presence of pinning centers at $\gamma = 0.1$ (lines *2*) and $\gamma = 2$ (lines *3*)

The differences in the influence of γ on the dependences $\langle\eta\rangle(S/S_{SC})$ in the regions of small and large values of S can be explained as follows. At $S \gg S_{SC}$ in the whole interval of γ under study, the largest value of $\langle\eta\rangle$ exceeds significantly the mean jump of a deformation on the dependence $\langle\eta\rangle(S/S_{SC})$. Since the quantity $(S - S^*)$ can decrease with γ by at most twice, the maximum value $\langle\eta\rangle$ at small values of γ can exceed the value of $\langle\eta\rangle$ at $\gamma \geq \gamma_c$ by at most the twofold value of a mean jump of a deformation at small values of γ. In the case where $S \geq S_{SC}$, the relative increase in the maximum value of $\langle\eta\rangle$ determined by one-two jumps at the decrease in γ turns out very large. This causes a significant increase in the loop area $\langle\eta\rangle(S/S_{SC})$, as γ decreases. The established influence of γ on the dislocation hysteresis testifies unambiguously to the important role of the viscosity in the formation of the jump of a deformation on the dependence $\langle\eta\rangle(S/S_{SC})$.

With the purpose to clarify the mechanism of influence of the viscosity on the process of formation of the jump of a deformation, we studied the shape of a separate segment of the dislocation loop the process of its incidence onto a pinning center. In Fig. 4 for three values of γ, we show the time dependence of a deformation at seven equidistant points of the segment. The central point has the coordinate ξ coinciding with the corresponding coordinate of a pinning center, whereas six other points are positioned always behind the region, where the force field of a pinning center acts. The central point corresponds to lower curves in Fig. 4. Figure 4,*a* shows that, at $\gamma > \gamma_c$, the motion of a segment of the dislocation loop occurs without any peculiarities: at all points, the deformation increases monotonically and attains the equilibrium value. For $\gamma \approx \gamma_c$, the segment of the dislocation loop passes through the equilibrium position at the incidence onto a pinning center (Fig. 4,*b*), which causes an increase in the angle of incidence of the dislocation onto the pinning center. As γ continues to decrease (Fig. 4,*c*), the angle of incidence increases additionally at the expense of the kinetic energy of a dislocation loop.

These results indicate that the increase in the jumps of a deformation on the dependences $\langle\eta\rangle(S/S_{SC})$ with increase in γ is caused by the inertial mechanism of overcoming of pinning centers by a dislocation [9–12]. Let us consider immovable dislocation loops which have equal or close values of $\langle\eta\rangle$ at the same S but moved prior to the stop and the repinning at different values of γ (e.g., points C and D or K and L at $\gamma = 0.1$ and $\gamma = 2$, respectively, in Fig. 3,*a, b*). The comparison of their shapes testifies that an immovable repinned dislocation loop after the motion at $\gamma < \gamma_c$ (i.e., with a manifestation of the inertial effect) has always a more pronounced zigzag-like shape than an immovable repinned loop after the motion at $\gamma > \gamma_c$. The more pronounced zigzag-like shape of a loop ensures larger initial incidence angles for a part of pinning centers, which causes, in turn, the separation of such a loop at lower stresses ($S_C < S_G$ in Fig. 3,*a*, and $S_K < S_M$ in Fig. 3,*b*).

Thus, the action of the inertial mechanism during the motion of a dislocation through the network of pinning centers affects the distribution function of dislocation segments over incidence angles for a repinned dislocation loop.

We studied the influence of the viscosity on the amplitude dependences of the damping decrement $\delta(S/S_{SC})$ and the elasticity modulus defect $\Delta M/M(S/S_{SC})$. In

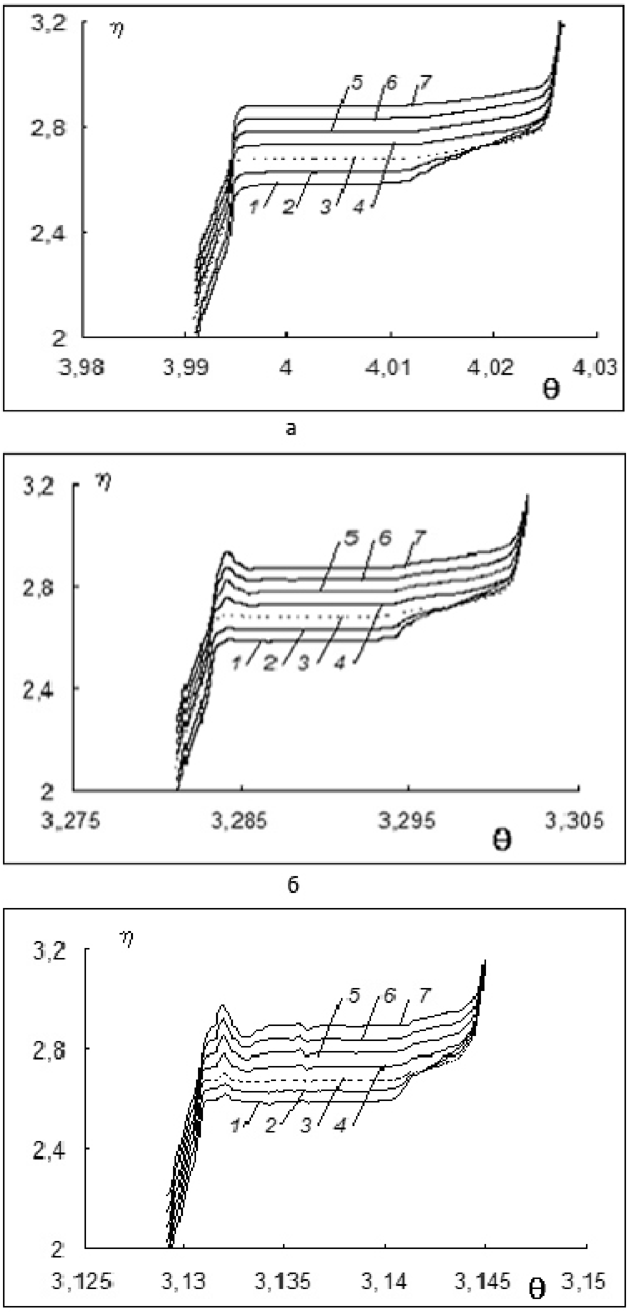

Fig. 4. Time dependence of a deformation η at seven points of a segment of the dislocation loop which are positioned from one another at a distance of $3\eta_0$ at its incidence onto a pinning center at various values of the normalized viscosity: $\gamma = 4$ (Fig. 4,*a*), $\gamma = 2$ (Fig. 4,*b*), $\gamma = 1.5$ (Fig. 4,*c*). Lines 1 correspond to a point of the dislocation loop with the coordinate ξ coinciding with the coordinate of a pinning center; lines *2, 3, 4* and *5, 6, 7* correspond to points which are located to the left and right from the point with the coordinate ξ, respectively, outside the region, where the force field of a pinning center acts

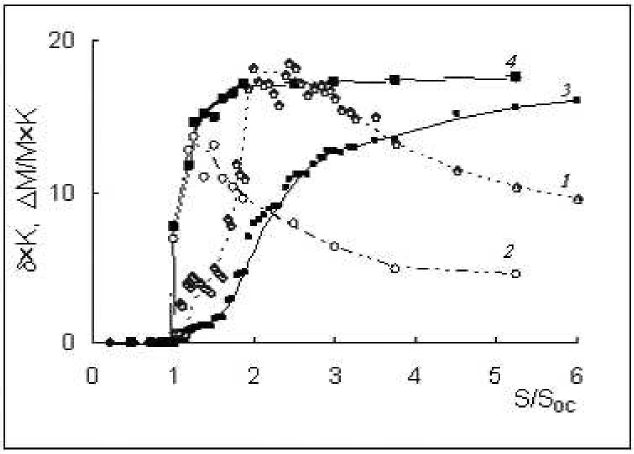

Fig. 5. Influence of the viscosity on the amplitude dependences of the damping decrement δ (lines *1* and *2*) and the elasticity modulus defect $\Delta M/M$ (lines *3* and *4*). Lines *1* and *3* are obtained at $\gamma \geq \gamma_c$, lines *2* and *4* – at $\gamma = 0,1$; K is a dimensionless factor

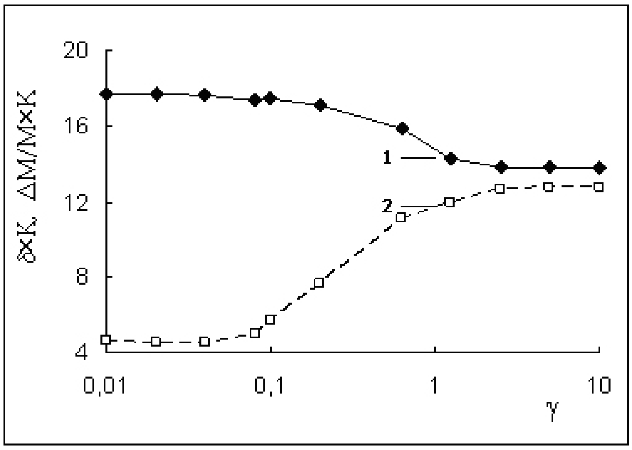

Fig. 6. Dependences of the damping decrement δ (line *2*) and the elasticity modulus defect $\Delta M/M$ (line *1*) on the normalized viscosity at a fixed value of the amplitude $S/S_{SC} \approx 4$, K is a dimensionless factor

Fig. 5 for two values of γ, we present such dependences obtained by averaging for ten random distributions of pinning centers in the slip plane. We established that, like the case of the dependence $\langle\eta\rangle(S/S_{SC})$, the influence of $\gamma \geq \gamma_c$ on the amplitude dependences of the damping decrement and the elasticity modulus defect is completely absent, Moreover, such an influence is practically absent also in the region $\gamma \leq 0.1$ (Fig. 6).

As γ increases, the decrement decreases at small values of the stress amplitude in the region $S \geq S_{OC}$ and increases at large values of S ($S \gg S_{SC}$).

At all values of γ, the dependences $\delta(S/S_{SC})$ have always a clearly manifested maximum, whereas the dependences $\Delta M/M(S/S_{SC})$ reveal the tendency to the saturation. The presence of the mentioned maximum and its position depends on the shape of a dislocation hysteresis loop.

At the approximation of the dependence $\langle\eta\rangle(S/S_{SC})$ in the region $\gamma \geq \gamma_c$ by a parallelogram, the hysteresis loop area is given by some function $f(S/S_{SC})$, whose analysis for an extremum indicates the presence of a maximum at values $S/S_{SC} \approx 2$. This corresponds to the position of a maximum on the dependence $\delta(S/S_{SC})$ at $\gamma \geq \gamma_c$ (see Fig. 5) and agrees with results in [5]. All peculiarities of the influence of γ on the internal friction follow directly from the above-analyzed regularities of the influence of the viscosity on the dislocation hysteresis.

4. Conclusions

The obtained results allow us to draw the following conclusions:
– in the presence of pinning centers in the slip plane of a dislocation, the dependence of a dislocation deformation on an applied stress bears a jump-like character;
– the influence of the viscosity on both the dynamics of an oscillating dislocation and the dislocation hysteresis is determined by the inertial mechanism of overcoming of weak pinning centers by a dislocation;
– the action of the inertial mechanism leads to an increase in the mean value of the jump of a deformation on a dislocation hysteresis loop and to a change of the distribution function of dislocation segments over incidence angles;
– there exists the critical value of the normalized viscosity, above which its influence on the dislocation hysteresis disappears.

Since the presented analysis is carried out without regard for the thermal activation of the separation of dislocations, the established regularities are valid at low temperatures. Because the electron absorption in metals is the main mechanism of dissipation of the energy of a moving dislocation in this case, we may expect that the established regularities will reveal themselves under the low-frequency dislocation internal friction in metals at low temperatures. The results of work [13] devoted to the analysis of the superconducting transition on the low-frequency dislocation internal friction in alloys Pb–In are in good agreement with the above-performed numerical analysis. However, those results were obtained only for several values of the coefficient of damping B, which does not allow us to verify the derived quantitative regularities. The latter can be tested in studies of the temperature dependences of the dislocation internal friction in superconductors at temperatures near the superconducting transition. The comparison of the temperature dependences obtained in the normal and superconducting states will allow one to determine the character of the influence of the viscosity on the dislocation hysteresis in a wide interval of variations of the coefficient of damping B. No experimental studies of crystals containing pinning centers in the slip plane of dislocations are available at the present time.

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ДИНАМІКА ДИСЛОКАЦІЙ В ТВЕРДИХ РОЗЧИНАХ ПРИ ЗНАКОЗМІННИХ НАПРУЖЕННЯХ

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Р е з ю м е

Чисельними методами вивчено динаміку сталих коливань дислокаційної петлі за наявності в її площині ковзання слабких центрів закріплення. Аналіз виконано для нульової ефективної частоти вимушених коливань в широкому інтервалі амплітуд коливань і нормованої в'язкості. Встановлено критичне значення нормованої в'язкості, починаючи з якого вплив в'язкості на процес подолання дислокацією слабких центрів закріплення повністю відсутній. Вивчено механізми впливу в'язкості на динаміку дислокацій при знакозмінних напруженнях. При зменшенні нормованої в'язкості в інтервалі нижче її критичного значення величина стрибків деформації на гістерезисній кривій зростає, а напруження відриву перезакріпленої нерухомої дислокації зменшується. Показано, що такий характер впливу в'язкості на динаміку дислокацій зумовлений проявом інерційного механізму подолання дислокаціями центрів закріплення. Вивчено вплив в'язкості на амплітудні залежності внутрішнього тертя і дефекта модуля пружності. Характер впливу в'язкості на внутрішнє тертя добре узгоджується зі встановленими особливостями динаміки дислокацій при прояві інерційного механізму.