$$\ell_{ph,3} \approx \frac{2}{\Delta\omega_\ell}\sqrt{\frac{\ell}{|\nu| T_2}}\,. \tag{5}$$

For CS_2 we have $\ell_{ph,3} \simeq 0.3$ cm at $\Delta\nu \simeq 50\ \mathrm{cm}^{-1}$ and $\ell_{ph,3} \simeq 0.015$ cm at $\Delta\nu \simeq 1000\ \mathrm{cm}^{-1}$; this means practically complete suppression of SRS in a real experiment ($\Gamma(\infty) \simeq gA_0^2\ell_{ph,3}$, cf. (3)).

The authors are grateful to A.K. Shchednova for useful discussions.

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INFLUENCE OF THE MAGNETIC FIELD ON ELECTRONIC DECELERATION OF DISLOCATIONS

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Submitted 9 November 1970
ZhETF Pis. Red. 12, No. 11, 551 - 554 (5 December 1970)

In the last few years there appeared a number of papers devoted to an experimental study of the role of electrons in processes of low-temperature plastic deformation of metals (see, e.g., [1, 2]). Usually in the experiment the electronic contribution to the deceleration of dislocations is observed on going over from the normal state to the superconducting one and vice-versa, which is realized in practice by varying the magnetic field H at a temperature $T < T_c$. Although under the experimental conditions the deformed metal in the normal state is in a magnetic field, the experimental data on the value of the electronic deceleration of dislocations agree with theoretical estimates obtained for H = 0 [3, 4], which predict the absence of a dependence on T. This apparently is connected with the fact that in fact one uses weak fields (the strong-field criterion is $r \ll \ell$, where r is the Larmor radius and ℓ is the mean free path). As will be shown below, in a strong field H there should take place a temperature and a field dependence of the electronic deceleration.

We start with the system of equations of motion of the medium with moving dislocations, the kinetic equation for the electron distribution function, and the Maxwell equations; this system is analogous to the system obtained by Kontorovich [5]:

$$\rho\ddot{u}_i = \frac{\partial}{\partial x_l}[r_{il} - \langle\chi\Lambda_{il}\rangle] + \frac{1}{c}[\mathbf{j}\times\mathbf{H}]_i, \tag{1}$$

$$\left(\frac{\partial}{\partial t} + v_l\frac{\partial}{\partial x_l} + \Omega\frac{\partial}{\partial\phi} + \frac{1}{\tau}\right)\chi = e\mathbf{v}\hat{\mathbf{E}} - \Lambda_{il}\dot{w}_{il}, \tag{2}$$

$$\mathrm{rot\,rot}\,\mathbf{E} = -\frac{4\pi}{c^2}\frac{\partial \mathbf{j}}{\partial t}, \quad \mathrm{div}\,\mathbf{j} = 0. \tag{3}$$

In (1), the stress tensor τ_{ij} is connected with the elastic-distortion tensor w_{ij} by Hook's law; the remaining terms on the right are the deformation and induction forces applied to the medium by the electrons:

$$\Lambda_{ij} = \lambda_{ij}(p) - \bar{\lambda}_{ij}, \quad \bar{X} = \frac{\langle X \rangle}{\langle 1 \rangle}, \quad \langle X \rangle = -\frac{2}{h^3}\int d^3p \frac{\partial f_0}{\partial \epsilon} X \tag{4}$$

$\lambda_{ij}(p)$ is the deformation-potential tensor, and $\chi(\partial f_0/\partial \varepsilon)$ is the non-equilibrium addition to the Fermi distribution function f_0. The current density is $\vec{j} = e\langle\chi\vec{v}\rangle$. In (2), Ω is the cyclotron frequency, ϕ the phase angle, τ the relaxation time, and

$$\hat{\mathbf{E}} = \mathbf{E} + \frac{1}{c}\dot{\mathbf{u}} \times \mathbf{H} + \frac{1}{e}\nabla(\bar{\lambda}_{ij} w_{ij}).$$

Unlike the equations of [5], we have here in lieu of the deformation tensor $\partial u_i/\partial x_i$ the elastic-distortion tensor w_{ij}, which is not expressed in terms of derivatives of the vector of the geometric displacement u with respect to the coordinates. The difference between these quantities is due to the plastic deformation and is determined by the equation [6]:

$$\dot{w}_{ij} = \frac{\partial \dot{u}_j}{\partial x_i} + J_{ij}; \quad J_{ij} = J^0_{ij}\,\delta(\vec{\xi}), \quad J^0_{ij} = [\mathbf{q} \times \mathbf{V}]_i\, b_j, \tag{5}$$

where J_{ij} is the dislocation flux density. The expression for J_{ij} in (5) is for a unit dislocation, each point of which is characterized by a tangential vector $\vec{q}$ and a two-dimensional vector $\vec{\xi} \perp \vec{q}$; $\vec{V}$ is the velocity of the given point of the dislocation line and $\vec{b}$ is the Burgers vector. Allowance for plastic deformation makes it possible to determine the force acting on the dislocation at the same time as the electronic contribution to the volume force in (1) is determined. This is done with the aid of the energy and momentum conservation laws (a derivation for the case H = 0 is given in [7]). As a result we obtain for the force acting on a unit length of the dislocation the following expression:

$$\mathbf{F} = \mathbf{q} \times \vec{\Sigma}, \quad \Sigma_i = [\tau_{ij} - \langle \chi \Lambda_{ij} \rangle] b_j, \tag{6}$$

which differs from the Pich-Keller force by the electronic addition to τ_{ij}. We note that the Maxwell-expression tensor T_{ij} does not enter in in (6), unlike (1), where $c^{-1}[\vec{j} \times \vec{H}]_i = -\partial T_{ij}/\partial x_j$). Using a Fourier expansion, we can obtain with the aid of (1) - (3) and (5) an expression for F in integral form. The main characteristics of the deceleration force are easiest to reveal in the simple case of a uniformly moving linear dislocation with $\vec{q} \parallel \vec{H}$, using the isotropic electron dispersion law. An analysis shows that just as in the case of H = 0 [3, 7], the main contribution is due to the distortion of the lattice region close to the dislocation line. We present the result obtained for the case of a strong magnetic field ($\Omega\tau \gg 1$):

$$F = F_0\,\Omega\tau\, G\left(\frac{V\tau}{b}\right); \quad G(x) = x^{-1}\ln(x + \sqrt{1+x^2}) + x^{-2}(1 - \sqrt{1+x^2}). \tag{7}$$

The quantity F_0 coincides with the electron deceleration force when H = 0 ($F_0 \simeq -n\lambda^2(\mu v)^{-1}bV$, λ is the deformation potential, μ the Fermi energy, n the electron density; we shall not present the numerical factor). The quantity $\Omega\tau G$ characterizes the dependence of F on H and T in a strong magnetic field. Two limiting cases are of importance, corresponding to "slow" ($Vr/b \ll 1$) and "fast" ($Vr/b \gg 1$) dislocations. In the former case $F \simeq F_0\Omega\tau \sim VH\tau$, and the second differs qualitatively:

$$F \approx F_0\Omega\tau \frac{b}{V\tau} \ln \frac{V\tau}{b} \sim H \ln (V\tau).$$

Thus, when $\Omega\tau \gg 1$ there should be a linear dependence on H, and also a temperature dependence via τ. The question of which fields are strong for a plastically deformed sample, in which the time τ can decrease strongly, calls for an experimental investigation. In this connection, ultrasonic methods of observing the electron deceleration force may be more sensitive to the influence of the magnetic field.

We note in conclusion that the influence of a magnetic field on the motion of dislocations was considered in [8], but the calculation was not performed correctly, since the screening was not taken into account consistently in writing down the deformation interaction. The screening is specified beforehand, but it can be readily verified that it does not ensure satisfaction of the electroneutrality condition. This leads, in particular, to incorrect results for the electric field and current produced by the moving dislocation (the latter were estimated earlier in [9]).

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