PROC. JSSF-2, KYOTO, 1980
J. PHYS. SOC. JPN. 49 (1980) SUPPL. B, p. 20.

On the Interaction of Moving Dislocation with Soft Phonon Mode Close to the Phase Transition Point

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The paper discusses the anomalies of the dynamic dragging of dislocations due to their interaction with soft phonon mode close to the phase transition point T_c. The growth of the intensity of phonon-dislocation interaction, when the temperature T is approaching T_c and the critical frequency w_c is decreasing, is caused by the increasing of the density of critical phonons ($\sim w_c^{-1}$) as well as the cross-section of the phonon scattering ($\sim w_c^{-2}$). On the other hand the integral effect is considerably weakening because of the small value of the phase volume occupied in the reciprocal space by the low frequency phonons.

An analysis shows that the drag coefficient B of dislocation diverges logarithmically, when T tends to T_c and correspondingly w_c tends to zero: $B \sim \ln(T_0/w_c)$, where $T_0 = \min(T, w_s)$, w_s is the value of the order of the Debye frequency. The natural limit of the growth of B with decreasing of w_c is reached, when the frequency w_c is less than damping γ of the mode (an overdamped mode). In this region further growth of the drag coefficient B stops and the large logarithm $\ln(T_0/w_c)$ is replaced by $\ln(T_0/\gamma)$.

It is shown that the most advantageous situation from the point of view of the observability of the temperature anomalies of $B(T)$ near to the phase transition point takes place, when $w_c(T) \ll T_c \ll w_s$ i.e. when the density of normal phonons turns out to be small in comparison with the density of critical phonons. The mentioned singularities could appear also in high temperature ferroelectrics with high electrostriction and "plasma frequency" of soft mode and with low level of anharmonicity, of the damping γ and of the "velocity" $(\partial\omega^2/\partial\kappa^2)^{1/2}$ of critical phonons.