by means of this formula, turn out to be smaller by several orders of magnitude than those determined experimentally. The values of the effective ionization potential of argon and of the degree of quantum multiplicity used in the calculations are those presently known from the experimental research [6].

We note that when application of laser radiation of wavelength 0.35 μ and duration 20 nsec also revealed a decrease of the threshold breakdown intensity in Ar and Xe [8]. However, unlike breakdown by picosecond laser radiation, this fact has not yet been theoretically explained. The universally accepted theory of avalanche breakdown in the case of nanosecond pulses of radiation, predicts a monotonic increase of the threshold in breakdown intensity with increasing frequency of the laser radiation [9].

It is apparently necessary in the theory to take additional account of the specific nature of the processes in the optical band, particularly the influence of resonant transitions between excited states, effects of self-focusing, etc.

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MAGNETIC CONTRIBUTION TO THERMAL EXPANSION OF PALLADIUM

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The contribution of paramagnons to the thermal expansion of metals with primitive cubic lattices, in the nearest-neighbor interaction approximation, is determined by the relation [1]

$$\left(\frac{\delta a}{a}\right)_{eq} = \frac{\epsilon N}{3C}\, g(T), \tag{1}$$

where ε determines the change of the width of the unfilled band with increasing lattice, g(T) is a parameter that connects the electron correlation functions with the lattice periods at the different temperatures, with the energy U of exchange interaction on the atom, the polarization χ_p of the spins of

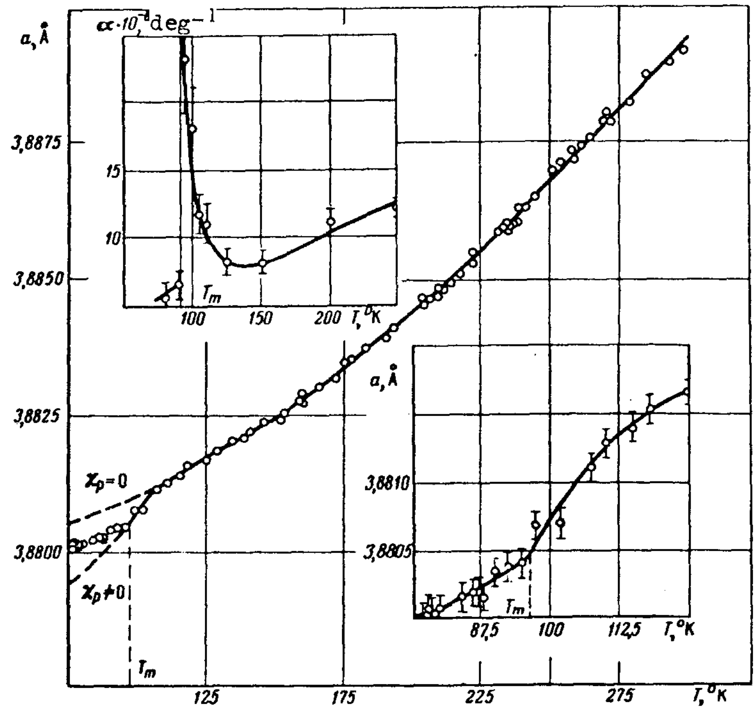

Fig. 1. Temperature dependence of the lattice periods and of the thermal expansion coefficient of palladium.

the conduction electrons in the unfilled band, and the coefficient j of electron-lattice interaction, while $C = C_{11} + 2C_{12}$.

a) If $\varepsilon > 0$, then $g(T) > 0$ (the usual case), $\chi_p = 0$ (the paramagnons are not ordered), and $(\delta a/a)_{eq} < 0$. The paramagnons cause contraction of the lattice in addition to the phonon and electron contribution to the thermal expansion.

b) If $\chi_p \neq 0$ (the paramagnons are ordered), then $g(T)_{\chi_p \neq 0} < g(T)_{\chi_p = 0}$, the contraction of the lattice decreases in the interval from 0°K to the temperature T_m at which the paramagnons become disordered. Above T_m, the contribution of the paramagnons to the thermal expansion is not equal to zero and corresponds to case a). A kink appears in the temperature plot of the lattice periods at the point T_m.

A calculation of the change of the spin polarization χ_p and of the parameters $g(T)$ with increasing temperature, for different values of the electron-lattice interaction coefficient ($j = 0 - 0.1$) and for different ratios of double the width of the unfilled band to the exchange energy per atom ($B = 0.5 - 2.0$), has shown [1] that χ_p and T_m decrease little with increasing j and strongly with increasing B.

The paramagnons in palladium were observed by neutron diffraction [2]. They increase the effective mass of the electrons of the 4d band [3 - 8], while the electric resistivity near 0°K acquires a term proportional to T^2 [9, 10]. The temperature dependence of the magnetic susceptibility has a maximum at ~90°K [11 - 17], and the electronic specific heat has a minimum [18, 19].

The purpose of the present investigation was to trace the influence of paramagnons on the thermal expansion and on the electric resistivity of palladium in the temperature interval 77 - 300°K.

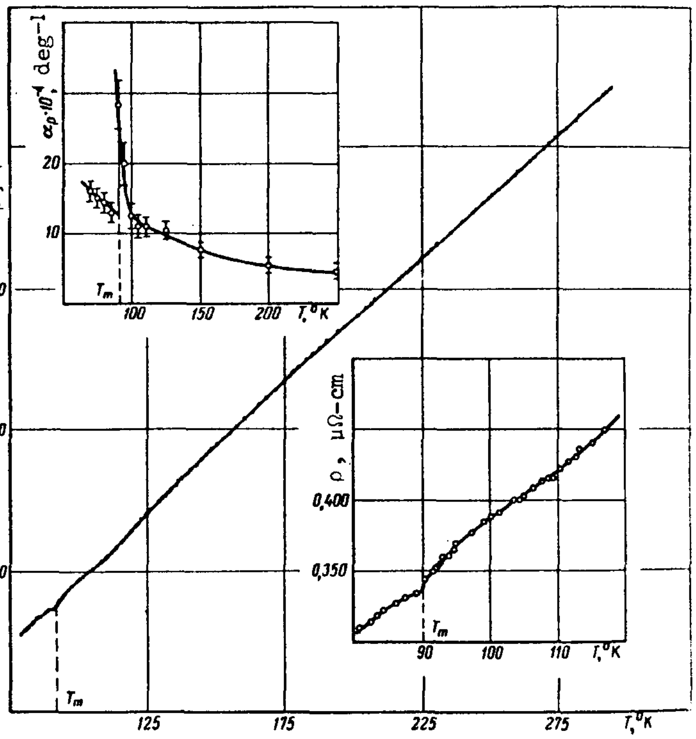

Fig. 2. Temperature dependence of the resistivity and of the coefficient a_ρ = (1/ρ)(dρ/dT) of palladium.

The investigations were performed on polycrystalline plates of palladium 0.13 mm thick (the metal was 99.98at.% pure), annealed in vacuum at 1300°K for 10 hours. The experiments were performed with a DRON-1 diffractometer equipped with a KRN-1 low-temperature attachment, using a procedure described earlier [20]. The temperature variation of the lattice periods was determined with a relative accuracy ±0.00008 Å.

The temperature dependence of the resistivity was measured at 77 - 300°K by a null method with a setup based on an R-309 potentiometer. The maximum relative error in the determination of the temperature dependence of the resistivity did not exceed ±0.2%, and the absolute error was ±2%. The temperature measurement accuracy was ±0.3°K.

The period of the FCC lattice of palladium increases monotonically at 77 - 95°K (Fig. 1). Near 95°K, the curve has a kink, and then with increasing temperature the period increases nonmonotonically, exhibiting a bend at ∿130°K, while in the interval 220 - 300°K the temperature dependence of the lattice period satisfies the empirical equation $a = 3.8764(1 + 11.65 \times 10^{-6}T + 2.59 \times 10^{-9}T^2)$ (in Å). The curve extrapolated from the paramagnetic region lies above the experimental one, while that extrapolated from the point of inflection lies below. The temperature dependence of the coefficient of external expansion experiences a discontinuity of $\sim 30 \times 10^{-6}$ deg^{-1} at 95 ± 3°K and has a minimum at ∿130°K.

The temperature dependence of the electric resistivity has a kink at 91 ± 3°K (Fig. 2). The coefficient $a_\rho = (1/\rho)(d\rho/dT)$ experiences a jump of 18×10^{-4} deg^{-1} at the kink point. The jumps $\Delta\alpha_a$ and $\Delta\alpha_\rho$ are negative. The results indicate that the temperature anomaly is equal to 93 ± 5°K.

It is assumed that in general outline relation (1) describes the contribution of the paramagnons to the thermal expansion of the cubic face-centered lattice of palladium. For the effective-mass value closest to the experiment

($m^*/m = 4 \pm 1$) [5] we have

$$UN(E_F) = 0.035 \pm 0.012. \tag{2}$$

According to the latest data [21, 22] the density of states on the Fermi surface of palladium is 2.281 ± 0.171 eV^{-1}, and the doubled width of the 4d-band is 1.29×10^{-4} eV. Using formula (2), we get $B = 0.013 \pm 0.007$. Extrapolation of the relation $kT_m/U = f(B)$ to $B = 0.013$ yields

$$\frac{kT_m}{U} = 0.38 \,. \tag{3}$$

From (3) we get for the disorder temperature of the paramagnons $T_m = 70 \pm 30^\circ\text{K}$. The obtained value is close to the experimentally obtained $93 \pm 5^\circ\text{K}$.

The shapes of the anomalies of the $\alpha_a(T)$ and $\alpha_p(T)$ curves near T_m point to singularities characteristic of a second-order phase transition.

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TEMPERATURE DEPENDENCE OF MULTIPHOTON IONIZATION OF THE HYDROGEN MOLECULE

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The resonant action of laser radiation on molecules is of great interest, being a new physical phenomenon of great practical importance [1]. An