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► To cite this version:

B. Stritzker. Superconductivity of disordered palladium. Journal de Physique Lettres, 1978, 39 (21), pp.397-398. 10.1051/jphyslet:019780039021039700 . jpa-00231526

HAL Id: jpa-00231526

<https://hal.science/jpa-00231526>

Submitted on 1 Jan 1978

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Classification
 Physics Abstracts
 74.10 — 74.70D

SUPERCONDUCTIVITY OF DISORDERED PALLADIUM (*)

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(Reçu le 23 août 1978, accepté le 15 septembre 1978)

Résumé. — On a observé la supraconductivité jusqu'à 3,2 K dans des films de palladium après irradiation à basses températures avec des ions He^+ .

Abstract. — Superconductivity up to 3.2 K has been found in Pd films after He^+ irradiation at low temperatures.

Very pure Pd films have been condensed onto substrates either at 4 K, 77 K or 300 K using various evaporation sources and methods. The as-condensed Pd films do not become superconducting above 0.08 K. Irradiation of these films with 130 keV He^+ ions at 4.2 K leads in all cases to superconductivity. The film thicknesses (200-400 Å) are chosen so that the He^+ -ions pass through the Pd. The maximum observed transition temperature, $T_{c\text{max}}$, amounts to 3.2 K for very small ion beam densities. $T_{c\text{max}}$ decreases with increasing density of the ion beam. T_c does not depend significantly either on the substrate (Al_2O_3 , SiO_2) or the evaporation conditions. Pd films evaporated with a rate of 80 Å/s by means of an electron-gun at 2×10^{-10} torr before and 5×10^{-9} torr during evaporation become superconducting after irradiation the T_c values are comparable with films evaporated at 3 Å/s and 10^{-7} torr.

Figure 1 shows the residual resistivity ρ_n of a Pd film condensed at 4.2 K versus the dose of He^+ -ions. After a steep decrease ρ_n saturates and superconductivity occurs. The decrease of ρ_n indicates that defects introduced during the quenched condensation partially anneal during irradiation. Annealing of this sample at 300 K results in a further decrease of ρ_n . Another 4.2 K irradiation of this annealed sample enlarges ρ_n again. ρ_n saturates at nearly the same value as before and the Pd film becomes superconducting at similar T_c values. This behaviour of the resistance indicates that superconductivity occurs in a phase

FIG. 1. — Residual resistivity ρ_n of a Pd film condensed onto a substrate at 4.2 K versus dose of irradiating He^+ -ions before and after annealing at 300 K. The hatched regions indicate the occurrence of superconductivity, with $T_{c\text{max}} = 2.5$ K corresponding to the high ion beam density used in this special experiment.

of medium disorder between those obtained after evaporation at 4.2 K and 300 K.

The occurrence of superconductivity in pure Pd is surprising because of its strongly enhanced paramagnetism. On the other hand there are some recent theories [1, 2] indicating the possibility of superconductivity in Pd at very low temperatures based on electron-phonon induced p-wave coupling. The occurrence of superconductivity in a disordered Pd phase, however, contradicts a p-wave mechanism in this phase. Possibly the defects lattice introduced suppress the harmful spin fluctuations, perhaps by Pd

(*) This paper has been presented at the LT 15 Conference as a post deadline paper.

atoms occupying interstitial sites as a result of the irradiation. In this connection a very recent paper [3] should be mentioned predicting a T_c of 0.3 K for Pd without spin fluctuations and s-wave coupling. It seems more reasonable to assume s-wave coupling in the observed superconducting disordered Pd.

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