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MAGNETIC PROPERTIES OF AMORPHOUS Ni-Pd-Si ALLOYS.

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Résumé.- La substitution partielle du palladium par des éléments possédant des électrons 3d tels que Fe, Co ou Ni change profondément les propriétés magnétiques de l’alliage amorphe Pd-Si. Nous avons étudié systématiquement la susceptibilité magnétique des alliages amorphes (NiPd)_{1-x}Fe Si en fonction de la température (4,2 < T < 580 K) et de la concentration (5 < x < 50). On discute brièvement de résultats obtenus.

Abstract.- The magnetic properties of amorphous Pd - Si alloys are significantly changed by partly substituting the Pd with 3d elements such as Fe, Co and Ni. The low-field magnetic susceptibility of amorphous (NiPd)_{1-x}Fe Si alloys was systematically investigated as a function of temperature (4.2 < T < 580 K) and concentration (5 < x < 50). We briefly discuss the obtained data.

INTRODUCTION.- In recent years, a number of amorphous metallic alloys based on Pd - Si have been prepared and investigated. The composition of these alloys is generally M Pd Si where M stands for Co, Fe, Cr, Mn, and Ni. These alloys, except for those containing Ni, exhibit localized moments and a Kondo-Type resistivity anomaly /1-3/. The magnetic properties of NiPd Si alloys were investigated by C.C. Tsuei, P. Duwez and R. Hasegawa /4,5/ for x ranging from 0 to 15 at. %. In this paper we present the results of the study of temperature dependence of the low-field magnetic susceptibility of amorphous (NiPd)_{1-x}Fe Si alloys with the content of Ni atoms up to 50 at. %.

EXPERIMENTAL METHODS.- All the amorphous alloys used in this study were prepared by rapid quenching technique. The concentration range within which an amorphous structure could be obtained was from 0 to 50 at. % of Ni. The ac susceptibility was measured by an induction method using the ac bridge of mutual inductance of the Hartshorn type. The alternating field used was about 60 A/m. The susceptibility was investigated in the temperature range 4.2 - 580 K.

RESULTS AND DISCUSSION.- The χ(T) results for alloys with Ni content x ≤ 20 are summarized in figure 1 and those for more concentrated alloys in figure 2. The inverse susceptibility χ(T) is also shown in these figures. The temperature dependence χ(T) can be characterized as follows: A constant and rather high value of the susceptibility in the temperature range from 4.2 K to room temperature.

At higher temperature the Curie-Weiss law was observed. Above about 450 K significant deviations from the linear behaviour of χ(T) have been observed. These deviations are connected with the process of crystallization of the metastable amorphous phase. The variation of χ with concentration x is characterized by a peak arising at a certain concentration as shown in figure 3, where curve 1...
is for constant part of $\chi(T)$, curve 2 for $T = 375$ K and curve 3 for $T = 475$ K.

Fig. 2: Magnetic susceptibility vs temperature for the (Ni$_{1-x}$Pd$_x$)$_{Si_{17}}$ alloys with $x \geq 30$ at.%. 

The constant low-temperature susceptibility suggests a description in terms of a band model of magnetism.

Fig. 3: Concentration dependence of magnetic susceptibility.

The high temperature decrease of $\chi(T)$ corresponds to a Curie term of between $0.92 \times 10^{-3}$ and $3.7 \times 10^{-3}$. C is a constant of order $10^2$. No consistent description can be found if the high-temperature Curie-Weiss behaviour is chosen as starting point. It is at present not clear whether this latter feature indicates a transition to a new state, or it can be connected with the single impurity effect discussed in /6/ by Cooper and Miljak.

References