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AMPLITUDE DISTRIBUTION OF POSITIVE AND NEGATIVE BARKHAUSEN JUMPS IN THE MAGNETIZATION PROCESSES OF METAL FERROMAGNETS

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The present paper presents the experimental results obtained in the investigation of the amplitude distribution of positive and negative Barkhausen jumps during the magnetization of the polycrystalline sample of carbonyl iron along one branch of the hysteresis loop. It follows that the negative Barkhausen jumps cannot be explained only by the changes of the secondary magnetic domain structure as supposed in [4]. The mechanism of the origin of negative Barkhausen jumps, as considered in paper [5], offers a qualitative understanding of the measured dependencies.

INTRODUCTION

It clearly follows from papers [1] and especially [2, 3] that in the magnetization process of metal ferromagnets there occur apart from irreversible magnetization processes leading to positive Barkhausen jumps, also irreversible elementary magnetization processes which lead to negative Barkhausen jumps. As soon as the existence of negative Barkhausen jumps has been proved the task arises to explain the machanism of the origin of the negative Barkhausen jumps. In his paper [4] Tebble offers a detailed theoretical consideration of the changes of the magnetic domain structure of the single crystal Fe sample, leading to the Barkhausen jumps. In this connection there arises even the possibility of the existence of such irreversible processes in the changes of the magnetic domain structure which lead to negative Barkhausen jumps. In these considerations the latter are brought into connection with irreversible changes of the secondary magnetic domain structure; Tebble therefore concludes that the changes of the magnetic moment of the ferromagnet, caused by the negative Barkhausen jumps, are 10^4 times smaller than the changes of the magnetic moment caused by the positive Barkhausen jumps, the origin of which is related to the changes of the structure of primary magnetic domains. How far Tebble's idea can be applied to explain the mechanism of the origin of the negative Barkhausen jumps observed during the magnetization of metal ferromagnets can be judged from the amplitude distribution of the positive and negative Barkhausen jumps in the course of the correspondent magnetization process. This is the aim of the present work.

EXPERIMENTAL RESULTS

The results obtained during the measurements have been obtained on carbonyl iron wire of 180 mm length and 0.6 mm diameter and will be given below. Before measurement the sample has been treated in the usual way in a hydrogen atmosphere. For the registration of the Barkhausen jumps an apparatus has been used the description of which has been given in paper [2]. For counting the Barkhausen jumps, which were realised in the course of the magnetization process, 6 counters adjusted for different discriminating values of the magnetic moment have been used. In Fig. 1 the integral amplitude distribution of both the positive (curve p) and the negative (curve n) Barkhausen jumps are illustrated during the magnetization process realized along the descendent branch of the hysteresis loop at a temperature of 295 °K. Since the investigation of the temperature dependence of the Barkahusen phenomenon revealed that the relative appearance of the negative Barkhausen jumps within the total number of Barkhausen jumps in the course of the magnetization process is more frequent at lower temperatures, the amplitu-

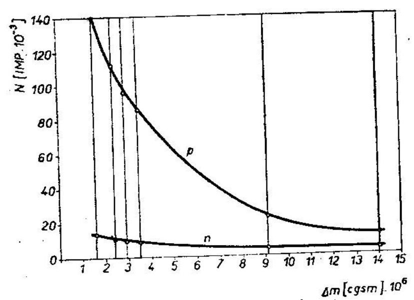

Fig. 1. Amplitude distribution of positive (curve p) and negative (curve n) Barkhausen jumps in the magnetization process of the Fe sample along the descending branch of the hysteresis loop at a temperature of 295 °K.

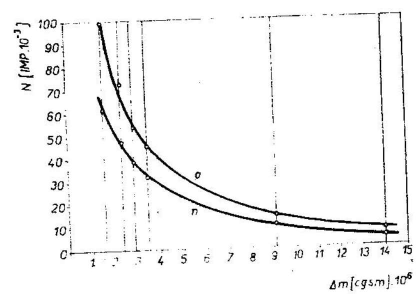

Fig. 2. Same as Fig. 1 at the temperature of liquid nitrogen.

de distribution of both positive and negative Barkhausen jumps has also been measured at the temperature of liquid nitrogen, 77 °K. The results of these measurements have been illustrated in Fig. 2. From both figures it is evident that in all sizes in which positive jumps occur a certain number of negative Barkhausen jumps can be registrated. Hereby it is interesting that in both temperatures that part or negative and positive Barkhausen jumps is practically similar to all values of the magnetic moment which form the discrimination level of the individual counters. At the temperature of 295 °K this part is about 10 % and at the temperature of 77 °K this part is somewhat higher than 60 %.

EVALUATION OF THE RESULTS AND SUMMARY

The results of the measurements illustrated in Figs. 1 and 2 unambiguously demonstrate that the negative Barkhausen jumps which can be observed in the magnetization process of metal ferromagnets are, as to their size, comparable to the positive Barkhausen jumps which are registrated in the same magnetization process. This is very well evident in the oscillogram — Fig. 1 of paper [3]. Thus it cannot be suggested that negative Barkhausen jumps could occur only as a result of a mechanism considered by Tebble in paper [4]. It is evident that similarly as the positive ones the negative Barkhausen jumps must also and mainly be related to the changes in the primary magnetic domain structure. It seems therefore to be much more probable that a substantial part of negative Barkhausen jumps arises as a result of a mechanism described in paper [5], where the existence of negative Barkhausen jumps has been brought into relation with the influence of the eddy currents, arising in the metal ferromagnets after the realisation of the positive jump. In this mechanism there are practically similar conditions for the origin of positive and negative Barkhausen jumps and both sorts of jumps may be related to the changes of both the primary and secondary domain structures. This mechanism enables the understanding of the existing mutual connection between the positive and negative Barkhausen jumps. This connection has been experimentally proved by the fact evident from Figs. 1 and 2 that the part of negative and positive Barkhausen jumps is practically constant for any value of the magnetic moment corresponding to these Barkhausen jumps.

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