4.4.4. MULTI-COMPONENT PROBE OF HALL TYPE FOR MEASUREMENT OF FERROMAGNETIC A- AND A′-PHASES IN AUSTENITIC STEELS

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In a sense, requirements to the ferrite phase content (FPC) are stricter than ones to the chemical composition of steel. Correspondingly, stricter requirements are imposed on testing methods, since small inaccuracy in FPC measurements can result in erroneous conclusion during evaluation of material quality. FPC regulation and testing in chromium-nickel steels of austenite and austenite-ferrite classes is a component of measures on provision of the quality of articles in many branches of industry both in our country and abroad.

In studies concerning the testing of quantity of Fe-α, as well as Fe-α′, it is demonstrated convincingly that magnetic method is more preferable than X-ray diffraction, metallographic, computational (by means of so-called structural diagrams on the basis of data about chemical composition of steel) and other methods. At the same time, it is known that measurement results obtained in different laboratories using magnetic instruments and devices of various designs with just the same specimens can differ.

One of the possible reasons of discrepancies consists in that, besides actual content of the ferromagnetic structural component, measurement result is influenced by the number of factors like morphology of ferromagnetic phase, for example. Sizes, shape and location peculiarities of particles can contribute or prevent penetration in them of magnetic field created by measuring device, which affects the value of magnetic signal measured by this instrument, especially, when relatively weak magnetic fields are applied.

Result of ferromagnetic phase (amount of deformation-induced martensite – DIMA, in particular) measurements can depend on measuring device design features and, first of all, on type of the steel magnetic characteristic used in this device as a measure of ferromagnetic component content. In this relation, such characteristics of steel as magnetic permeability and magnetization seem to be extremely convenient values. Their measurement is taken as a basis of operational principle of the widely spread portable instruments like ferritometers of various types and designs used in many countries. However, these characteristics are most sensitive to structure namely in such fields. In other words, result of their measurement depends not only on the amount of ferromagnetic material, but on its morphology as well.

As magnetizing force increases, magnetic saturation of all ferromagnetic particles is achieved irrespective of their sizes, shape, orientation and peculiarities of distribution in a metal. Amount of specific saturation magnetization $4\pi I^S$ of any ferromagnetic material is the steel characteristic, which is not sensitive to structure and is used in magnetic phase analysis as the most trustworthy measure of ferromagnetic component content of any degree of dispersion in paramagnetic array.

Presently, saturation magnetization can be measured only with laboratory installations. There are no instruments existed to measure the percentage content of deformation-induced martensite in local manner. Existed instruments of phase testing are referred to the category of ferritometers and determine ferrite phase, rather than deformation-induced martensite content (α′-phase). Magnetosensitive probes of these instruments create in testing zone magnetic fields of the order of 300 – 400 A/cm, which is not sufficient absolutely for magnetization of ferromagnetic phase up to saturation. Ferrite inclusions in

austenite material have shape that differs completely from one of deformation-induced martensite. Therefore, magnetization of these two phases occurs in different manner.

Authors have used this experimental and scientific fact in order to separate various magnetic phase components in austenite material of chromium-nickel steels.

The essence of method consists in that material in locally tested zone is magnetized in strong fields of the order of 3.500 A/cm. In this case, saturation magnetization is determined on calibration blocks by the scattering field. Saturation magnetization is composed of magnetizations of ferrite and deformation-induced martensite.

Then, instrument's probe is switched over into the mode of measurement of residual magnetization. It is proven convincingly by us that, when magnetic field is switched off, ferrite phase has magnetization close to zero (5 – 7% error) and the main contribution into the instrument's readings is made namely by deformation-induced martensite phase.

Having these two results (in saturation and residual magnetization), it is possible to separate quite confidently contributions of two ferromagnetic phases.

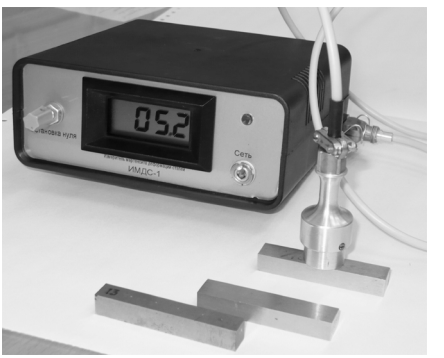

Fig. 1. IMDS-1 – Device for measuring deformation-induced martensite of steels

Method is implemented in instrumental version in the form of small-size "Device for measuring deformation-induced martensite" presented in fig. 1.