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THE PULSED MAGNETIC TREATMENT EFFECTS ON THE MECHANICAL PROPERTIES OF THE HEAT-TREATED HIGH-SPEED STEEL 19830.8

VLIV MAGNETICKÉHO PULZNÍHO ZPRACOVÁNÍ NA MECHANICKÉ VLASTNOSTI ZUŠLECHTĚNÉ RYCHLOŘEZNÉ OCELI 19830.8

Anotace

Tento článek popisuje vliv magnetického pulzního zpracování na mechanické vlastnosti zušlechtěné rychlořezné oceli 19830.8. Pulzní magnetické zpracování bylo provedeno se střídavým magnetickým polem s intenzitou 500 kA/m. Po magnetickém zpracování byly mechanické vlastnosti zkoušeny pomocí tahového testu. Tahové testy byly také pro srovnání provedeny na vzorcích bez aplikace magnetického pulzního zpracování. Magnetické intensity byly měřeny příčnou hallovou sondou. Z naměřených dat byly stanoveny střední hodnoty a směrodatné odchylky. Byly srovnávány střední průběhy mechanického napětí jako funkce poměrné celkové deformace vzorků s pulzním magnetickým zpracováním a bez.

Abstract

This paper describes the pulsed magnetic treatment effects on the mechanical properties of the samples from heat-treated high-speed steel 19830.8. The pulsed magnetic treatment was performed with of the alternating magnetic field. The magnetic intensity was 500 kA/m. After the pulsed magnetic treatment the mechanical properties of the samples were tested with the tension test. Magnetic intensities were measured with transverse Hall probe. From measuring results were determined average values and standard deviations. Average values of the stress as function relative total elongation of the samples with pulsed magnetic treatment and without, have been compared.

Introduction

The pulsed magnetic treatment mechanism was explained with residual stress reduction [1]. The residual stresses in material are created during their technology processing. The residual stresses sources are e.g. different plastic strains when the material is heat treated [2]. A micro-mechanism model of residual stress reduction by low frequency alternating magnetic field treatment is described at [3]. This model is based on microstructure observation with transmission electron microscope (TEM). TEM observation indicated that the pulsed magnetic treatment caused dislocation distribution balancing. The dislocation distribution becomes much more uniform although the dislocation density did not change significantly.

One of the way how the alternating magnetic field causes change of the dislocation distribution are magnetostriction vibrations. Ferromagnetic material like iron, is known to exhibit positive magnetostriction (elongation) in magnetic field of low magnetic intensity (<12kA/m) and negative magnetostriction (contraction) in magnetic field of high intensity (>40kA/m) [4].

The present paper specifically focuses on describing changes of mechanical properties heat-treated high-speed steel 19830.8. These changes are caused with the pulsed magnetic treatment and they are evaluated with the tensile test.

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Experiment and results

Steel 19830.8

The samples were done from the steel 19830.8, which was heat-treated. The steel 19830.8 is high speed steel for manufacturing cutting tools and sheer dies. Chemical composition of the studied steel 19830.8 is in Table. 1.

Table. 1. Chemical composition of steel 19830.8

C	Mn	Si	P	S	Cu	Cr	Ni	Al_{cel}	Mo	W	V	Co
0,93	0,3	0,27	0,023	0,01	0,15	3,94	0,17	0,016	4,73	5,67	1,786	0,01

Pulsed magnetic treatment mode

Power supply for the production of magnetic field is composed from power audio amplifier BVaudio PA2000BM. The output of audio amplifier is connected to two coils. The coils have shunt connection. Winding inductance is compensated with serial connected capacity. The input of the audio amplifier is modulated with function frequency generator. The pulsed magnetic treatment mode is described with these parameters:

- frequency 50Hz (sinusoidal wave)
- magnetic intensity 500 kA/m
- duration of the treatment 400s

Magnetic intensity was measured with transverse Hall probe Fig.1. The measuring magnetic intensity was used a divide sample (Fig. 1.)

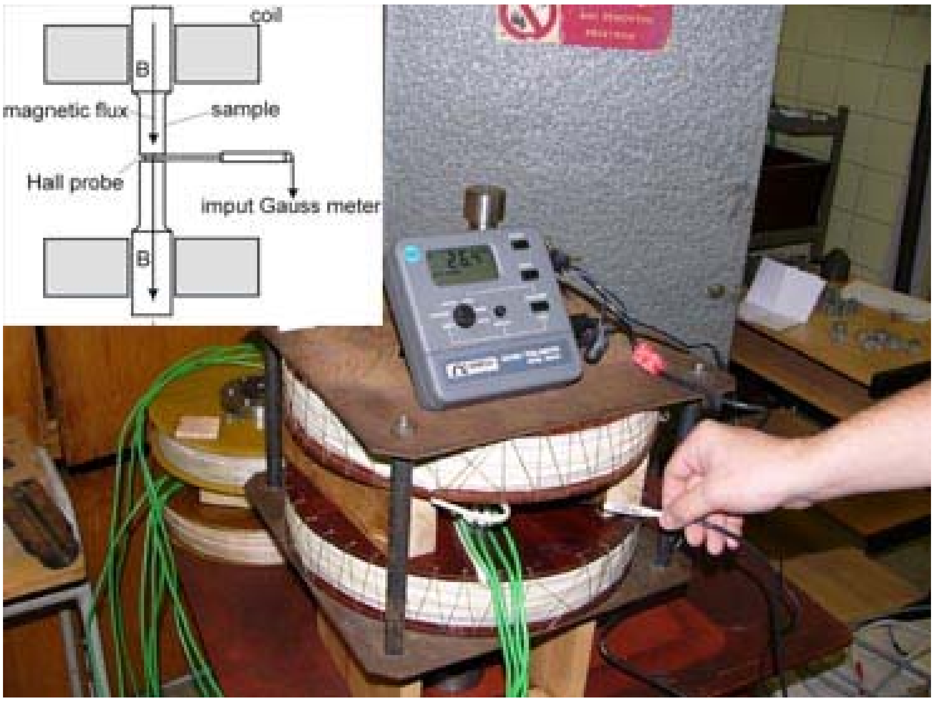

Fig. 1 The measuring magnetic intensity with transverse Hall probe

Tensile test

Sample for tensile test is shown on Fig. 2. The samples were loaded with tensile test to fracture, after the pulsed magnetic treatment.

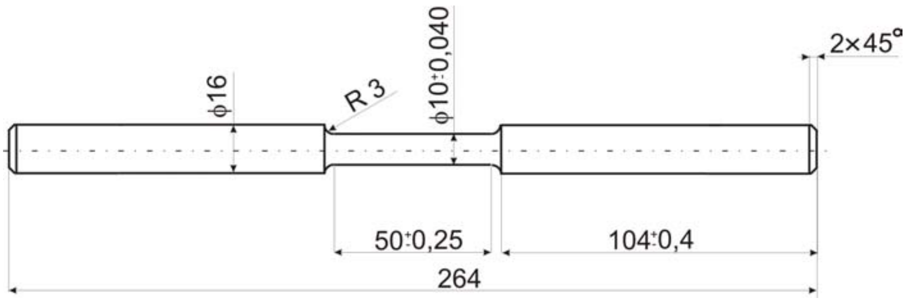

Fig. 2 Sample for tensile test.

The samples without the pulsed magnetic treatment were tested for confrontation too. From measuring results were determined average values:

- the stress as function relative total elongation (ε) of the samples with pulsed magnetic treatment and without for comparison (Fig. 3)
- average total strains at fracture ($\varepsilon_T = \varepsilon_{plastic} + \varepsilon_{elastic}$)of the samples with pulsed magnetic treatment and without for comparison (Fig. 3)
- and standard deviations (δ) for both (Fig. 3)

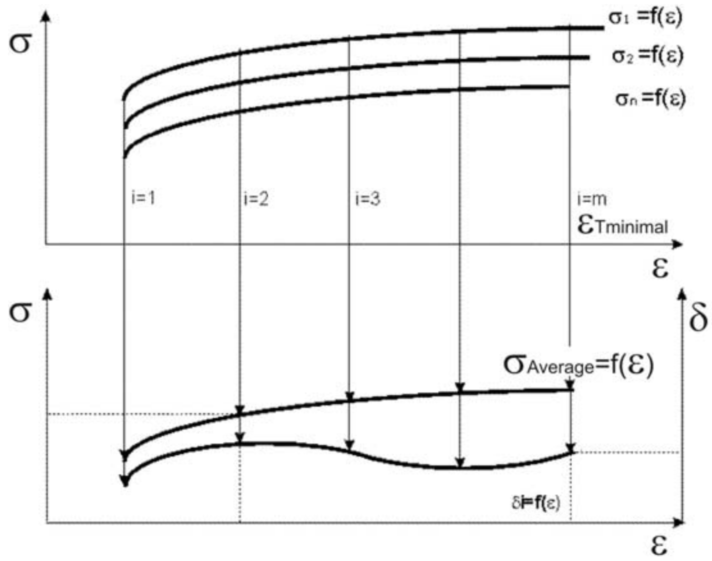

Fig. 3 The measuring results evaluation

The pulsed magnetic treatment effect is represented with differences between the average stress curves, which were measured with pulsed magnetic treatment and without. The differences values are compared with accumulation standard deviations, which are determined by Gauss quadratic law accumulation errors

$$\delta_A = \sqrt{\delta_{with}^2 + \delta_{without}^2}$$

The pulsed magnetic treatment effect on the average total strains at fracture was evaluated in like manner.

Results

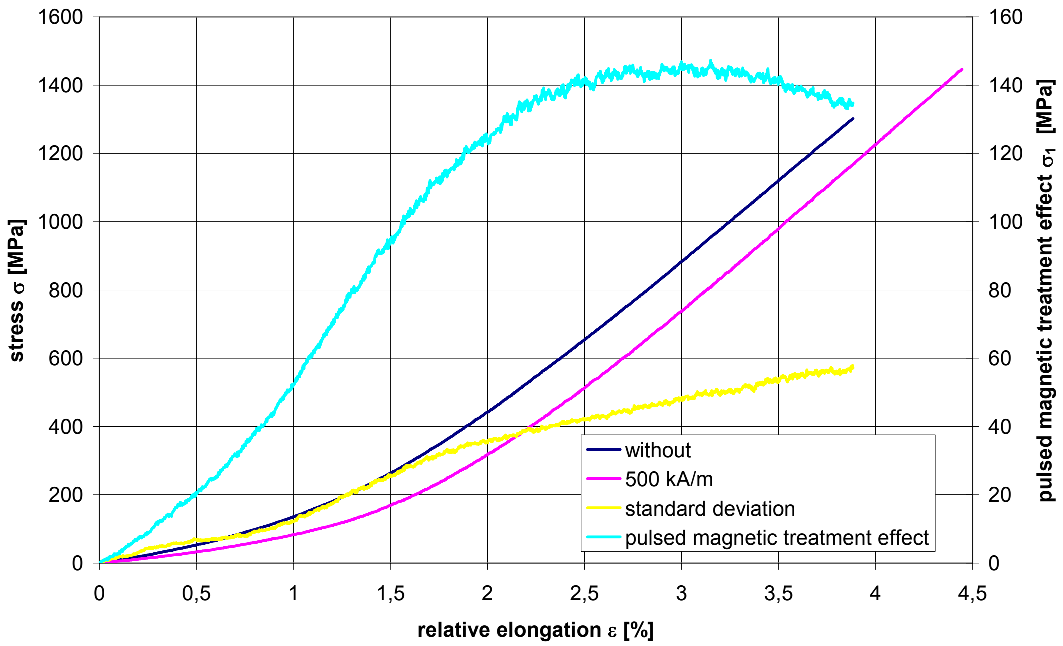

Fig. 4 Comparison of average stress curves with pulsed magnetic treatment and without. The pulsed magnetic treatment effect vs. the accumulation standard deviations

Table. 2 Comparison of average total strain at fracture with pulsed magnetic treatment and without. The pulsed magnetic treatment effect vs. the accumulation standard deviations

	ε_T (%)	δ (%)	δ_A (%)	pulsed magnetic treatment effect (%)
pulsed magnetic treatment	9,077	0,315	0,379	2,903
without	6,174	0,210		

Discussion and conclusions

The pulsed magnetic treatment caused relation change of the average stress curve as function relative total elongation. The all tension tests were ended fracture at the shoulder place of the testing samples. From this results, that the heat-treated high-speed steel is very sensitive on notch effect. After the pulsed magnetic treatment the sensitive on notch effect was decreased. The sensitive on notch effect indicates the presence residual stress. This residual stress is caused with the heat treatment. Although the residual stress values have not been measured, we assume that the pulsed magnetic treatment effect is connected with its reduction. The pulsed magnetic treatment caused increasing fracture stress about 144 MPa (Fig. 4). The pulsed magnetic treatment effect is over accumulation standard deviation (Fig. 4).

If we make comparison of average total strains at fracture with application pulsed magnetic treatment and without, then we find that the pulsed magnetic treatment caused increasing, which is over accumulation standard deviation (Table 2).

Generally say, presented paper results that the pulsed magnetic treatment improves mechanical properties of the heat-treated high-speed steel 19830.8. Further research will be follow in this field of interest in our workplace.

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