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# MULTIPLE ALLOYED DAMPING STEEL TO REDUCE NOISE AT MANUFACTORING

**Annotation**

The paper studies the physical, mechanical and chemical characteristics of multiple alloyed damping steel. The results of the heat treatment and TGA.

**Keywords:** chemical compound of steel, damping properties, heat treatment, the noise level, the elastic properties of physical-mechanical properties of the alloy, microstructure.

**Кілт сөздер:** болаттың химиялық құрамы, демпферлік қасиеті, термиялық өңдеу, шу деңгейі, беріктілік қасиеті, қорытпаның физикалық-механикалық қасиеті, микроқұрылымы.

**Ключевые слова:** химический состав стали, демпфирующие свойства, термообработка, уровень шума, упругие свойства, физико-механические свойства сплава, микроструктура.

## 1. Introduction

In modern times for parts of machines and mechanisms, working in repeated loading mode, there are materials with high damping capacity, which are used frequently. Using of such materials becomes one of the most effective methods of noise reducing. The main restriction of extensive use of mentioned materials with high damping capacity in industry is high cost of some materials (non-ferrous alloys), its poor assortment, and additionally designers are not always satisfied with complex of its physical and mechanical characteristics, strengthening most of all.

Along with use of mathematical planning method of experiments there were developed damping multiple alloyed steel (0.48% C; 0.88% Ce; 0.65% Nb; 1.44% Mn; 0.28% Si; 0.08% Ti; the rest is Fe), characterized by increased dissipative properties during impacts owing to creation of structures with increased dislocation content, magnetoelastic hysteresis and elastic twinning; at the same time there were received regression equations, which evaluate a contribution of every alloying element in dissipation effect.

Characteristics of an internal friction of steel: Internal friction, $Q^{-1}$, $\times 10^4$ = 23.7, Specific Electroresistance, ρ, Om·m·$10^6$ = 8.02 and Level of a Sound: 60 dBA.

The reason of the raised attenuation of sound energy in alloys is phonon dispersion and also elastic twinning and magnetic losses.

In table 1 elastic properties of the investigated steel such, as the shift module, the module of Yung and levels of a sound of alloys are presented. The module of Yung defines elastic properties of a material.

Table 1 – Elastic properties of investigated alloys

| № | Period of fluctuations, T, c | $T^2$, $c^2$ | Shift module, $G\times10^{10}$, Pa | Module of Yung, $E\times10^{10}$, Pa | Level of sound, dBA |
|---|---|---|---|---|---|
| 1 | 0,0942 | 0,0088 | 8,2035 | 20,2350 | 60 |

**2. Carrying out of Experiment and Results of work**

In all works on research damping properties of metal materials for an estimation of structural components on effect damping used metallographic analysis, in the present work for the first time it is used thermogravimetrical the analysis of alloys.

In the given work spent thermogravimetrical analysis of damping multiple alloyed steel.

With the help thermogravimetric differential scanning calorimeter STA 409 PC we can define phase transitions iron-carbon alloys that concretizes definition of damping mechanisms.

In the given work defined phase transitions of developed new multiple alloyed steel with the help thermogravimetrical differential scanning calorimeter STA 409 PC. In figure 1 presented result of thermogravimetrical analysis of multiple alloyed damping steel.

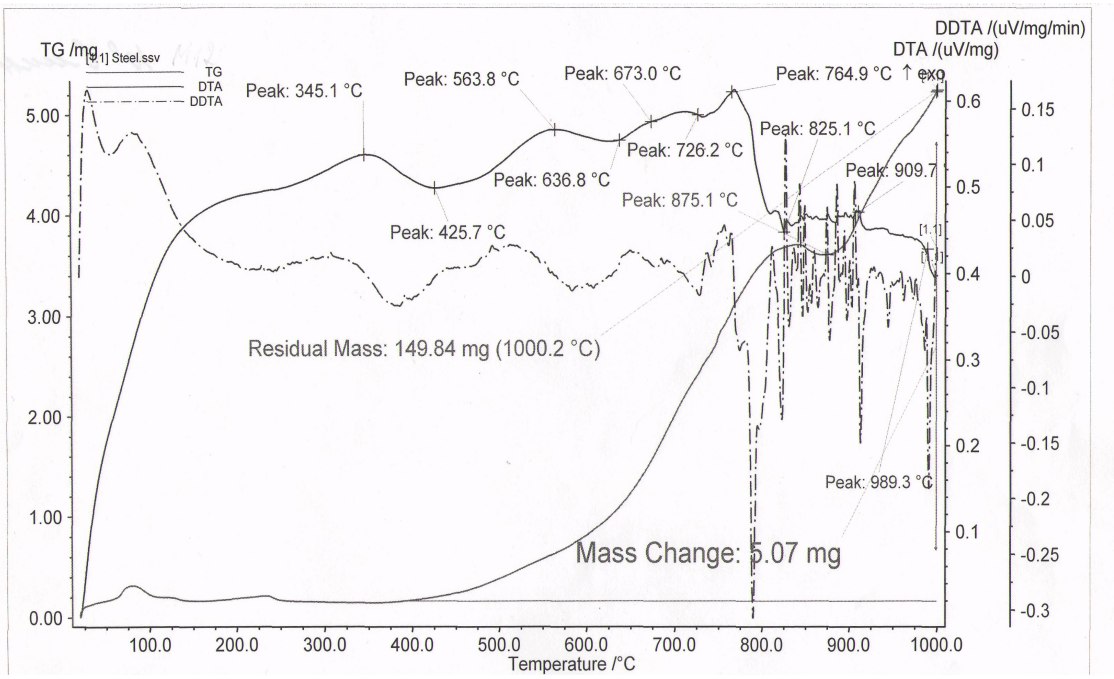
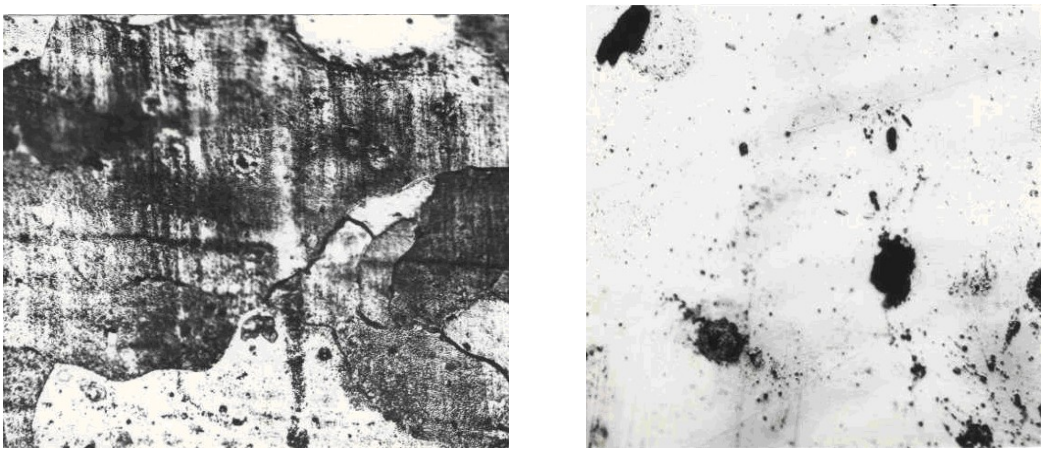



Figure 1 – Thermogravimetrical analysis of damping multiple alloyed steel

Endothermal peaks are fixed at temperatures: 345.1$^0$C, 563.8$^0$C, 673.8$^0$C, 764.9$^0$C, exothermal peaks at: 425.7$^0$C, 875.1$^0$C, 909.7$^0$C. Endothermal peaks speak a complex of the phase transitions occurring in such difficult system, presence of a magnetic phase of iron and the magnetic transitions connected with it. At temperature 780$^0$C the austenite phase – a firm solution, carbon introduction in γ - iron is formed at alloying by chrome, niobium, cerium, titan, vanadium, manganese, silicon also formation of a new crystal lattice of the sample occurs. It essentially influences on damping properties of an alloy. Exothermal effects speak oxidation processes a surface of the sample since heating was conducted in air atmosphere.

Microstructure of alloy (0.48 % C; 0.88 % Ce; 0.65 % Nb; 1.44 % Mn; 0.28 % Si; 0.08 % Ti; the rest is Fe) represents ferrito-pearlite a mix. Light sites on etched samples represent ferrite, dark – pearlite. Cerium enough (0.88 %) is a basis for creation of separate nonmetallic inclusions (aluminosilicates, silicides) which are especially well visible on not etched samples.

In figure 2 are presented microstructures of developed new damping multiple alloyed steel.



a b

a) In a cast condition; b) without etching

Figure 2 – Microstructure of alloy, increase – 320

The analysis of a microstructure of alloy shows that the microstructure without etching (figure 2b) finds out the nonmetallic inclusions which are concentrators of pressure, braking movement of a sound wave, i.e. the heterogeneous mechanism of dissipation is observed. In figure 2a it is visible that nonmetallic inclusions have the considerable sizes that strengthens effect dissipation, besides, it is necessary to notice that alloy concerns to ferromagnetic (over 90 % – Fe), means is present magnetomechanic effect of attenuation of sound energy.

Effect of damping in multiple alloyed steel is increased at complex actions of elastic twinning, magnetoelastic hysteresis, martensitic structure, which are revealed by thermogravimetric method of structure analysis.

**3. Conclusion**

1. One of possible mechanisms "background" damping in alloys is phonon dispersion; in the metastable lattice characterized by raised own energy and it is sharper strained, than in a stable condition, anisotropy, at distribution of waves of elastic pressure there are favorable conditions for origin phonons, original movement «phonon» gas; at a meeting phonons to obstacles of type of defects of a crystal lattice or with each other there is the dispersion of the energy shown in the raised phonon damping; with rise in temperature and increase in the general metastability of a crystal lattice dispersion sharply increases.

2. In the investigated alloys one of mechanisms damping is elastic twinning, consisting in reversible displacement twin borders at reorientation in a polydomain crystal or in occurrence and growth of doubles at the appendix of loading and full or their partial disappearance at loading removal.

3. Attenuation of elastic fluctuations in the developed ferromagnetic alloys above, than in not ferromagnetic; this results from the fact that along with energy dispersion at mechanical fluctuations which is caused by the mechanisms inherent in the majority of firm bodies, the

magnetic losses connected with magnetomechanical hysteresis, from macrovortical currents and from microvortical currents are peculiar to ferromagnetic materials also.

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Алматы қ.

ӨНДІРІСТЕ ШУДЫ БӘСЕҢДЕТУГЕ АРНАЛҒАН КҮРДЕЛІ ЛЕГІРЛЕНГЕН ДЕМПФЕРЛІ БОЛАТ

**Резюме**

Жұмыста күрделі легірленген демпферлі болаттың физикалық-механикалық, химиялық сипаттамалары зерттелінген. Термиялық өңдеу және термогравиметриялық талдау нәтижелері ұсынылған.

**Кілт сөздер:** болаттың химиялық құрамы, демпферлік қасиеті, термиялық өңдеу, шу деңгейі, беріктілік қасиеті, қорытпаның физикалық-механикалық қасиеті, микрокұрылымы.

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## СЛОЖНОЛЕГИРОВАННАЯ ДЕМПФИРУЮЩАЯ СТАЛЬ ДЛЯ СНИЖЕНИЯ ШУМА НА ПРОИЗВОДСТВЕ

**Резюме**

В работе исследованы физико-механические, химические характеристики сложнолегированной демпфирующей стали. Приведены результаты термообработки и термогравиметрического анализа.

**Ключевые слова:** химический состав стали, демпфирующие свойства, термообработка, уровень шума, упругие свойства, физико-механические свойства сплава, микроструктура.

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