STRUCTURE CHANGES IN METALS DURING THEIR LASER TREATING

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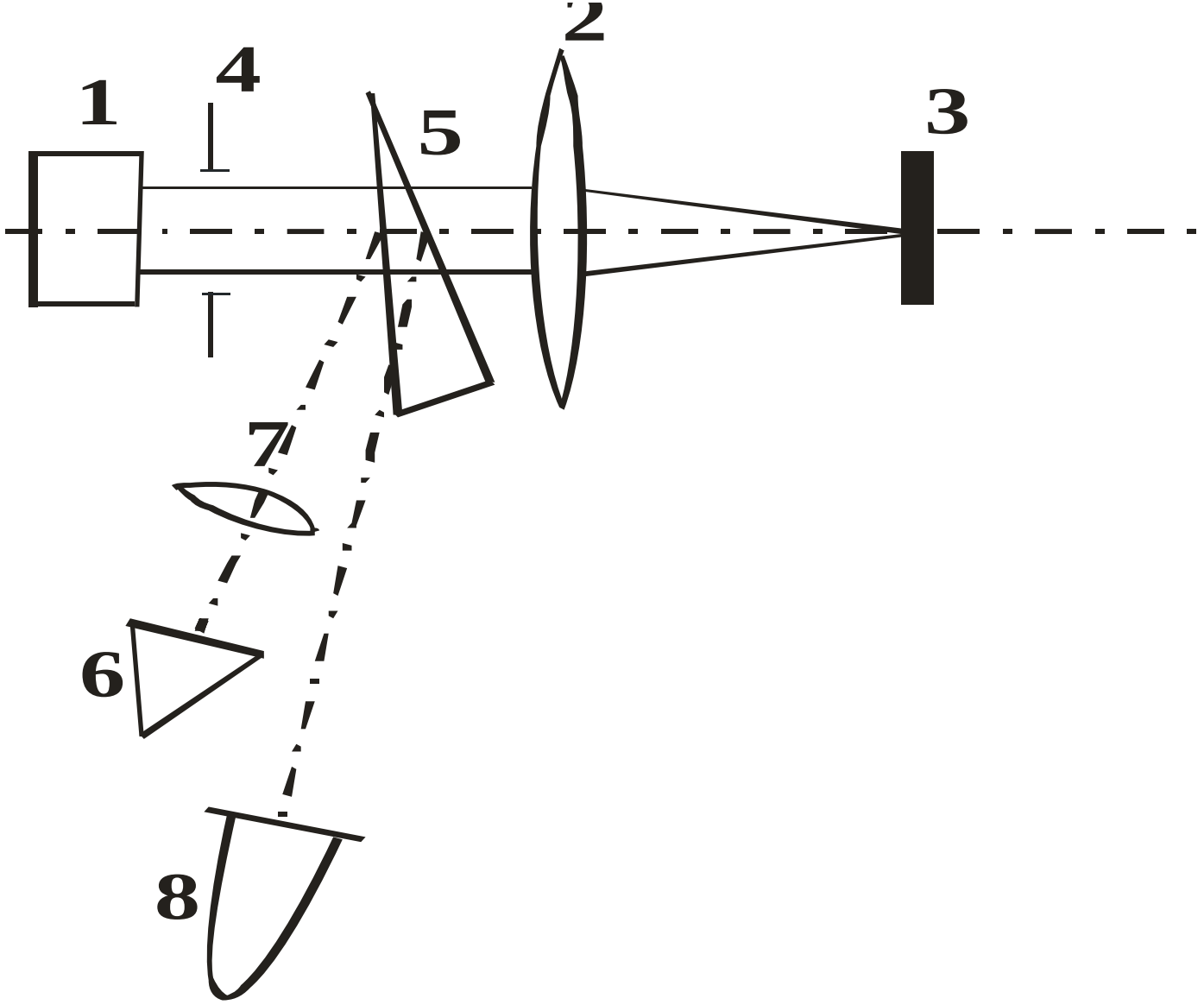
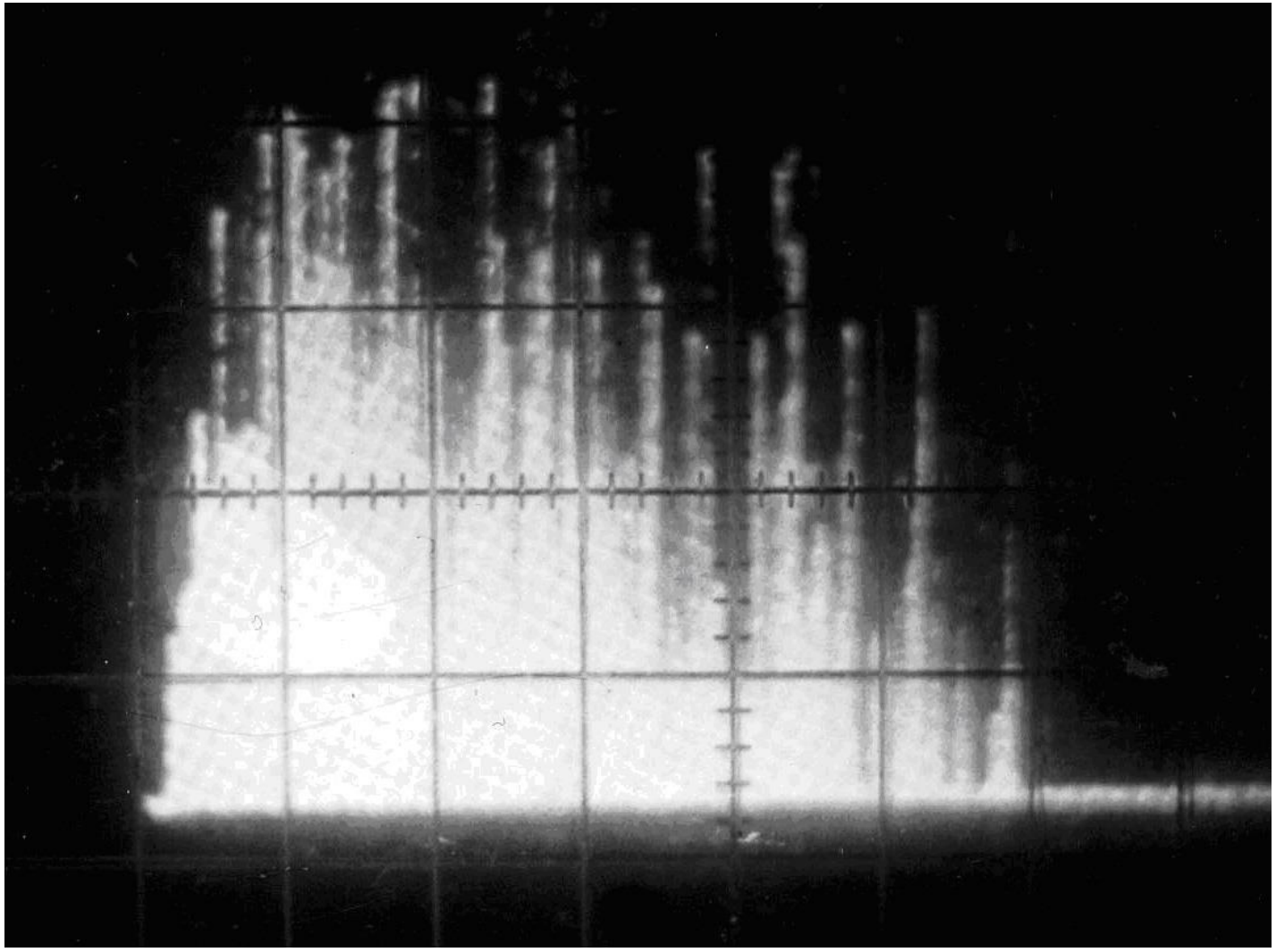
The aim

- The aim of this work is to study the changes and of the structure of a number of metals exposed to laser radiation with a flux density of 10^4 - 10^5 W/cm^2, as well as explanation of the detected structural changes.

SCHEME OF THE EXPERIMENTAL SETUP



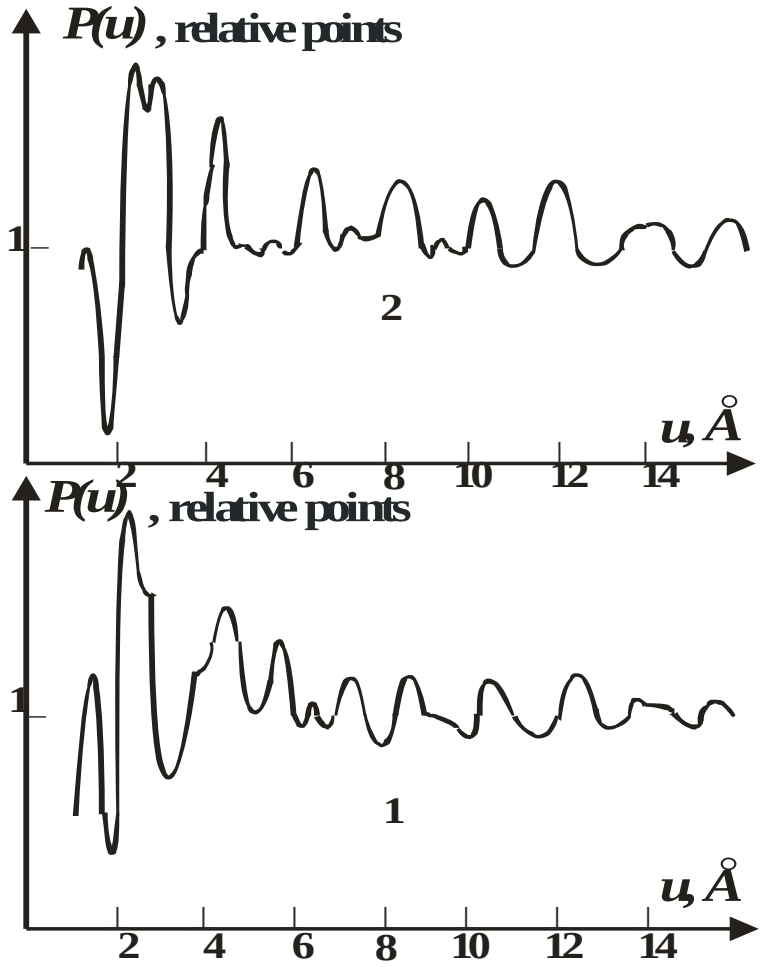
Oscillogram of the radiation pulse from the GOR-100M laser. The scanning rate is 200 m/s div^{-1}.



Parameters of the correlation functions of a copper sample before and afte rlaser irradiation with $q \sim 5 \cdot 10^5 W/cm^2$

№	Theoretical values		Unirradiated sample			Irradiated sample		
	a, Å	K	a, Å	Δ, Å	K	a, Å	Δ, Å	K
1	2,550	12	2,58	0,7	13	2,48 2,60	1,2	6 6
2	4,416	24	4,50	0,5	26	4,50	1,0	24
3	5,100	12	–	–	–	–	–	–
4	5,702	24	5,75	0,6	36	5,82	0,3	36
5	6,246	8	6,40	0,3	5	–	–	–
6	6,746	48	6,80	0,3	45	6,50	0,8	52

Correlation functions P (u) for copper samples (1) – before irradiation, (2) – after laser irradiation.



The proportion of cells that changed their state

First maximum of correlation function shows that 83% of the cells are subject to transformation.

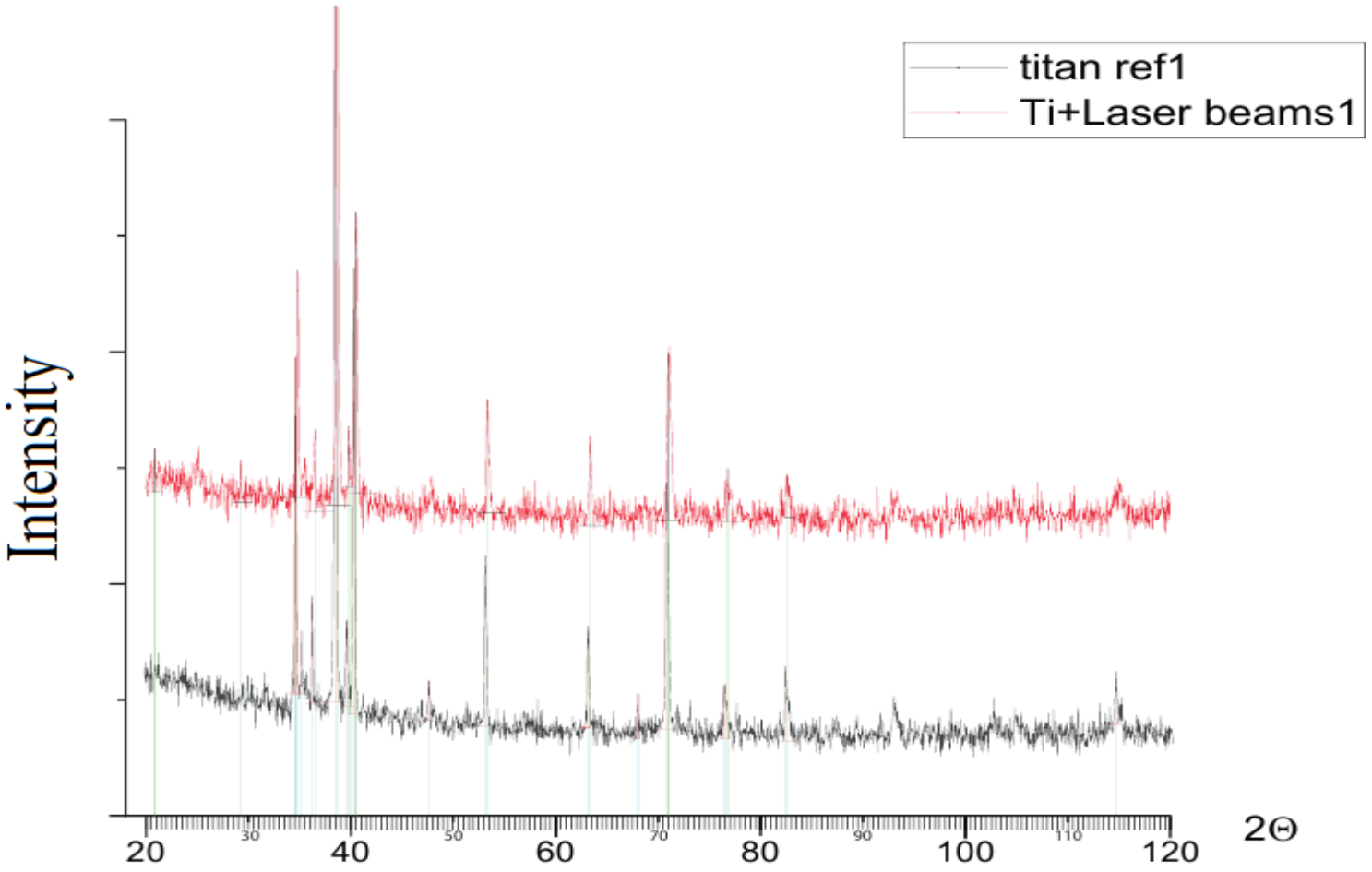
h = λ = 0.694 μm d = 2 mm $V_{Cu} = \frac{\pi d^2}{4}\lambda = 2{,}17 \cdot 10^{-12}\ m^3$

$N_{cell} = \frac{V_{Cu}}{V_{cell}} = 4{,}65 \cdot 10^{16}\ cells$ $E_{cell} = \frac{3}{5}E_F = \frac{3}{5}\frac{\hbar^2}{2m_e}\left(\frac{3\pi^2 \rho N_A}{\mu}\right)^{\frac{2}{3}} = 4{,}14 eV$

$N_{trans} = \frac{E_{abs}}{E_{cell}} = \frac{3{,}12 \cdot 10^{19}}{4{,}14} = 7{,}53 \cdot 10^{18}\ cells$ Only ~ 0.5% of E_{abs} penetrates the sample

81% of the total number of cells will change the crystal structure.

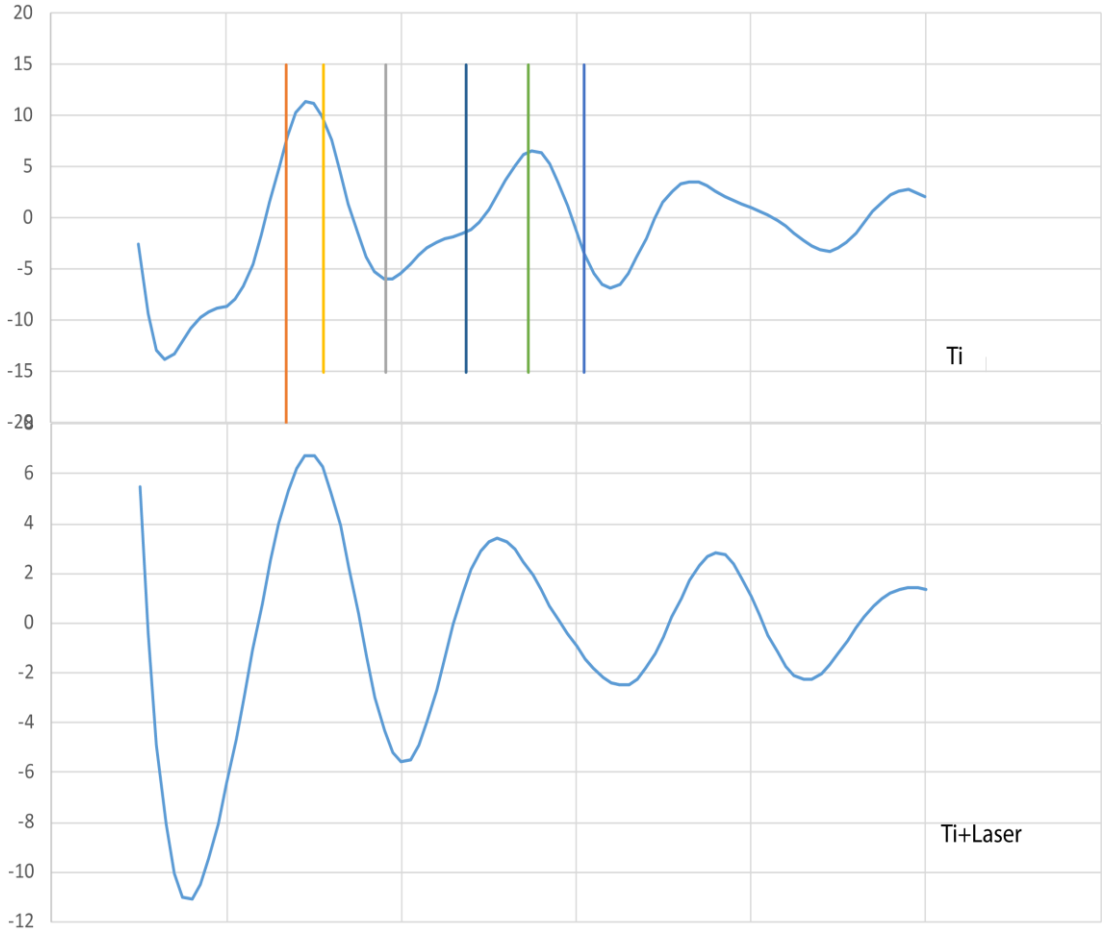
X-ray patterns of α – Ti before (lower) and after (upper) laser treatment.



Comparison of X-ray diffraction patterns of α – Ti before (1) and after (2) irradiation: average, smallest (min) and largest (max), theoretical values of the cell parameters which determined by all reflexes, σ_{11} - standard deviation of the parameters.

		The average	min	max	σ_{11}	Theory
a	1	2,708	2,546	2,992	0,18	2,937
	2	2,518	2,364a	2,577	0,09	
c	1	4,747	4,660	4,956	0,12	4,582
	2	4,660	4,421	4,923	0,21	

Correlation functions P (u) for titanium samples (1) – before irradiation, (2) – after laser irradiation.



The calculations show that after treating of titanium sample by laser radiation with the flux density $q \sim 5 \cdot 10^5$ W cm^{-2} number of crystalline elementary cells were subjected to the transformation from the cubic side-centered to the distorted (having a form of parallelepiped, different from the cub) can reach 50 %.

Micro-hardness of titanium samples in the irradiated zones also considerably (50 %) increased.

CONCLUSIONS

The investigations showed that under the action of laser radiation on the surface of metal samples, their crystal structure changes in the irradiated zone from cubic face-centered to distorted (having a parallelepiped shape different from the cube).

thank you for attention