A SELF-ORGANIZATION PHENOMENON IN THE LASER SYNTHESIS OF NITRIDES ON TITANIUM, ZIRCONIUM AND HAFNIUM SURFACES IN A LIQUID NITRIGEN MEDIUM

T.N. KHATKO

Physical and Engineering Institute of Academy of Sciences of BSSR, Zhodinskaya 4, Minsk 220730, USSR

It is shown theoretically and experimentally that a chemical medium subject to laser radiation acquires the ability to self-organization. This process can be controlled by changing laser beam parameters, i.e. intensity, a beam radius and wavelength. It is known that on titanium, zirconium and hafnium surfaces placed into liquid nitrogen and subjected to laser radiation there proceeds chemical synthesis of nitrides. Here a melting surface chemically interacting with nitrogen plays the main role. In the present work it has been revealed experimentally that at millisecond IR-laser irradiation ($\lambda = 1.6 \mu\text{m}$) of titanium, zirconium and hafnium surfaces being in a liquid nitrogen medium there is observed a self-organization phenomenon in a thin surface layer of melted metal interacting with nitrogen which results in formation of a 5-20 μm layer with a structure that differs essentially from that of a melting zone. Scanning electron microscopy and metallographic examination have revealed that the surface layer of a melting zone formed on a titanium surface consists of columnar TiN crystals having the same size and being equidistant from each other. Similar structures have been observed on zirconium and hafnium surfaces. A cross size and height of TiN crystals as well as a distance between them have depended on laser radiation power density ($q = 10^5 - 10^8 \text{ W} \cdot \text{cm}^{-2}$), impulse duration ($\tau = 1-6 \text{ ms}$) and a spot radius ($r = 500-2000 \mu\text{m}$). At $q = 1,2 \cdot 10^6 \text{ W} \cdot \text{cm}^{-2}$, $\tau = 4 \text{ ms}$ and $r = 1 \text{ mm}$ the above parameters have amounted to 1.5; 10 and 2.5 μm , respectively.