



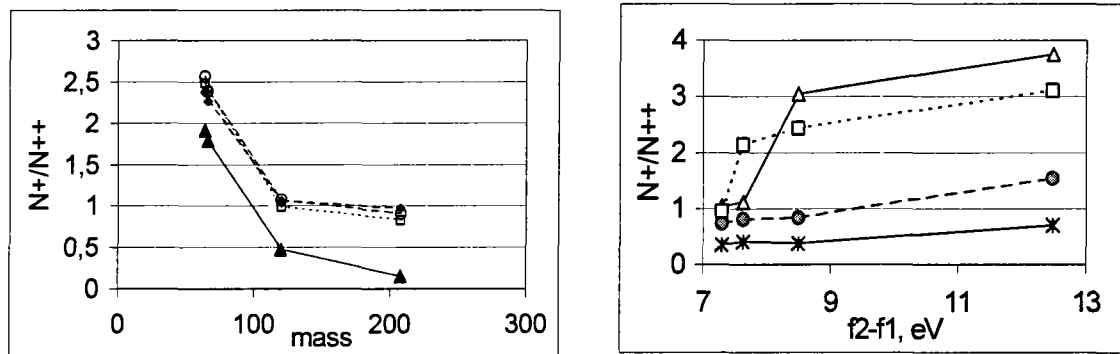
## Excessive Yield of Second Charged Ions of Heavy Elements in Laser Plasma Expansion Process

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LAMAS-10M TOF-MS that was recently designed for inorganic quantitative analysis is also well suitable for investigation of laser irradiation interaction with solids. This feature allows one to analyze plasma on early stage and gives an excellent possibility to complete existent physical model. This work is dedicated to investigation of yield doubly charged ions for different elements.

The analyses of reference samples with LAMAS-10M TOF-MS show excess of the relative yield of doubly charged ions for heavy elements. Obtained data may be selected between two groups. First group shows decreasing a value  $N^{+1}/N^{+2}$  vs. mass, second group shows decreasing a value  $N^{+1}/N^{+2}$  vs. the value  $f_2-f_1$  ( $f_2$  and  $f_1$  are the ionization potentials).



For example, the relative yield of  $^{208}\text{Pb}$  ions with charge +1/+2 is equal to 1-0.5, whereas for  $^{63}\text{Cu}$  the yield amounts to 2-2.5. The electrons, being lighter than ions, at first move from the center of the plasma cloud to the rim. It results to "uncovering" of uncompensated positive charge. The electric field arising by this way returns the electrons to the center of the cloud, and accelerates them up to significant energy  $E \sim 100$  eV. Since in this case the flight of ions depends on mass, the concentration of heavy ions in the center of the cloud is higher than the concentration of light ions. This fact results in more effective ionization for heavy ions and appearance of the secondary ions with the charge +2. At long plasma lifetime, the processes of recombination begin that result in distribution of charges. However, in this case, a destruction of plasma occurs at early stage and non-equilibrium

distribution of ions and charges remains. Indeed, practically in all spectra an excess of doubly-charged ions is registered.

Experiments carried out on reference sample "bronze 663" confirm introduced above supposition: increase of yield ions is registered at increasing mass of element. The dependence of relative yield of ions upon the mass is approximated by the function  $N+1/N+2=m/n$ .