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MASSES OF MODIFIED ATOMS OF TUNGSTEN ISOTOPES

Mikhail Kashchenko
Ural Federal University, Yekaterinburg, Russia
Ural State Forestry University, Yekaterinburg, Russia
mpk46@mail.ru
Maksim Kovalenko
Ural Federal University, Yekaterinburg, Russia
Vladimir Pechorsry
Ural State Forestry University, Yekaterinburg, Russia
Nadezhda Kashchenko
Ural Federal University, Yekaterinburg, Russia

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Abstract

The mass spectra of modified tungsten atoms with increased masses, detected on a titanium anode during arc discharges in air using a tungsten cathode, are presented. The calibration of the spectra is discussed in sufficient detail. The results indicate the existence of massive compact electron (ee)-pairs that change the chemical properties of atoms by reducing the effective charge of the nucleus when (ee)-pairs are included in the electron shell, or when pseudonuclei are formed.

Keywords: hadron mechanics, (*ee*)-pairs, mass spectra, modified atoms, tungsten isotopes.

The mass spectra of tungsten isotopes were presented in reports, and were partially presented in the preprint [6], but were not discussed in detail.
It is clear that experimental confirmation of the existence of massive (*ee*) -pairs is of fundamental importance for the implementation of low-temperature nuclear synthesis [2, 3, 4, 7], therefore these spectra are given below with a fairly detailed discussion of the calibration results, which ensures, in particular, the reliability of the data in Table 1.

Experimental details

Fig. 1 schematically shows an arc discharge in air between a tungsten cathode and a titanium anode. Three arc discharge channels (indicated by arrows) symbolize that the single channel that actually exists can change orientation and shape during the discharge. During the discharge, the cathode material is partially destroyed, and a coating containing tungsten atoms forms on the anode surface. Typical values of voltage U and current I are given, as well as the diameters of the electrodes and the gap between them.

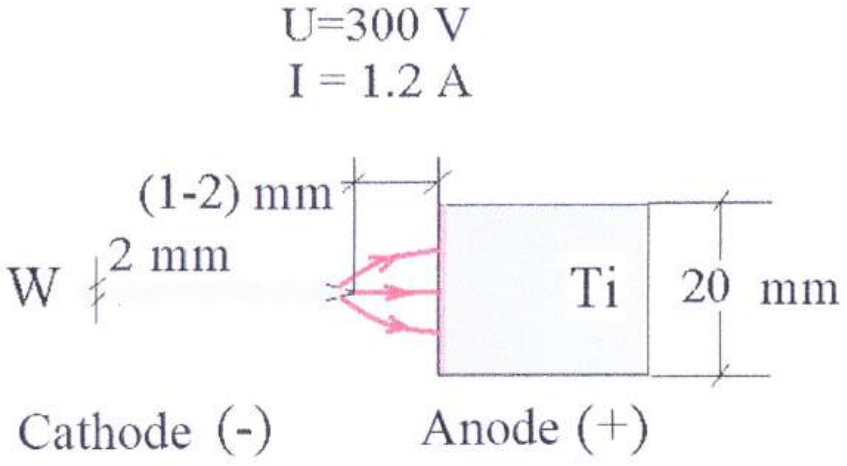

Fig. 1. Scheme of arc discharge in air environment

During an arc discharge in an air environment between a tungsten cathode and an anode made of different materials, the cathode material is

partially destroyed, and a coating containing tungsten atoms is formed on the anode surface. In this work, a scraping from the surface of a titanium anode in the form of a powder with characteristic sizes of powder particles of about 10 - 100 μm was studied. The resulting powder was pressed (pressed) into indium foil, placed in the analyzer chamber of the mass spectrometer, which was pumped out to a high vacuum of about 10^{-6} Pa.

The analysis method used was time-of-flight mass spectrometry of secondary ions in static mode (PHI TRIFT V nano TOF device). In the analytical gun, the primary gold ions have an energy of 30 keV. If it is necessary to clean the surface of the sample, sputtering with argon ions with an energy of 5 keV is used. The method is very surface-sensitive, in fact, several outer atomic layers are studied Primary short - term sputtering allows to remove the upper layer of sorbed gases, water and other possible surface contaminants. Further sputtering allows to study the composition in the volume of samples.

The typical mass resolution in the studied samples is $m/\Delta m \sim 4000 - 7000$, which allows peaks with a mass difference of ~ 0.02 amu to be distinguished. The spectra were calibrated using the most intense known peaks characteristic of the sample.

Results

An anomalous mass shift of tungsten isotopes, which arrived during the discharges from the tungsten cathode, was detected on the samples from the titanium anode. The general spectrum of the sample after primary sputtering is shown in Fig. 2.

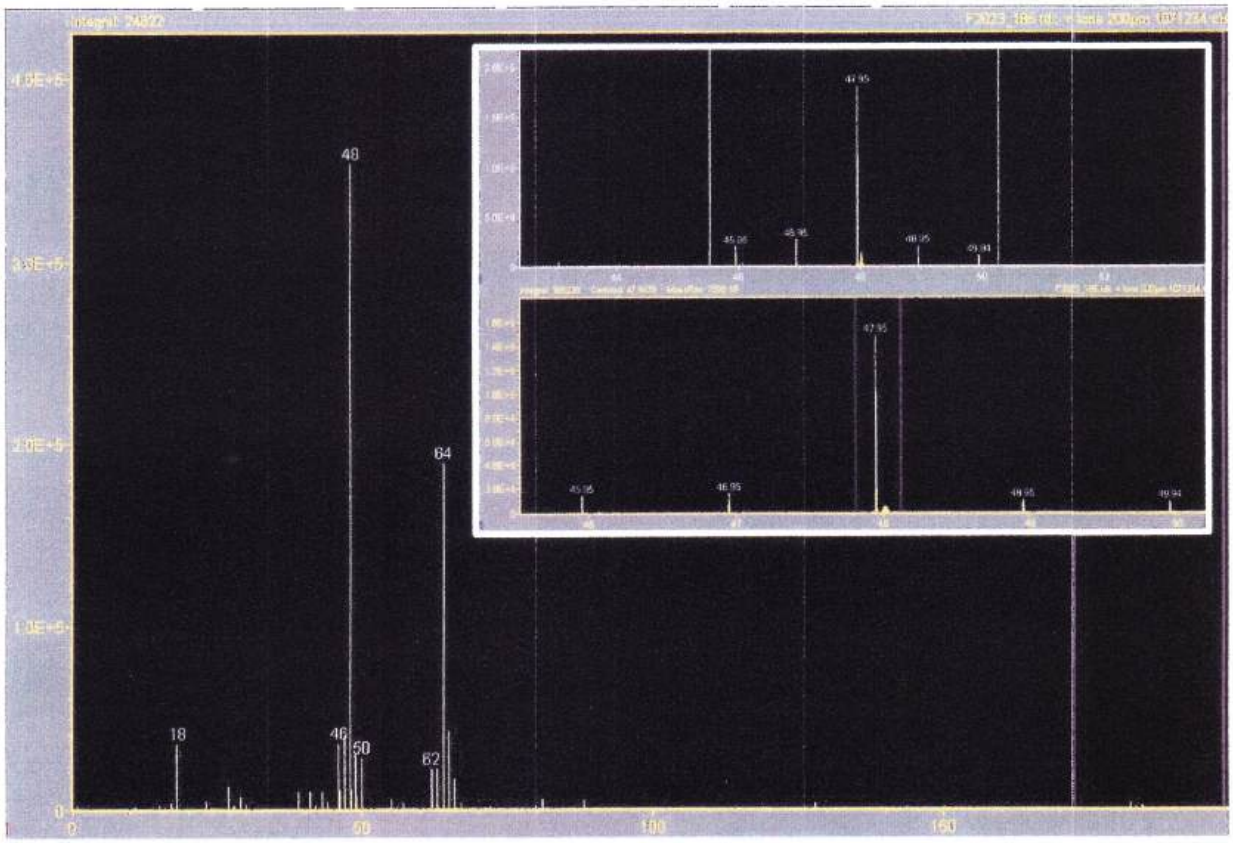

Fig. 2. General mass spectrum of titanium anode samples. The inset shows titanium isotopes.

The main peaks are titanium isotopes (titanium dominates - 48), titanium oxide

(peaks around 64 mass), water at 18 mass. The inset shows that the titanium isotopic composition is natural, the mass resolution is $m/\Delta m = 7600$.

The spectrum on these samples was calibrated using the peaks of hydrogen, ^{48}Ti, and oxide ^{48}TiO. The region of the mass spectrum including tungsten is shown in Fig. 3.

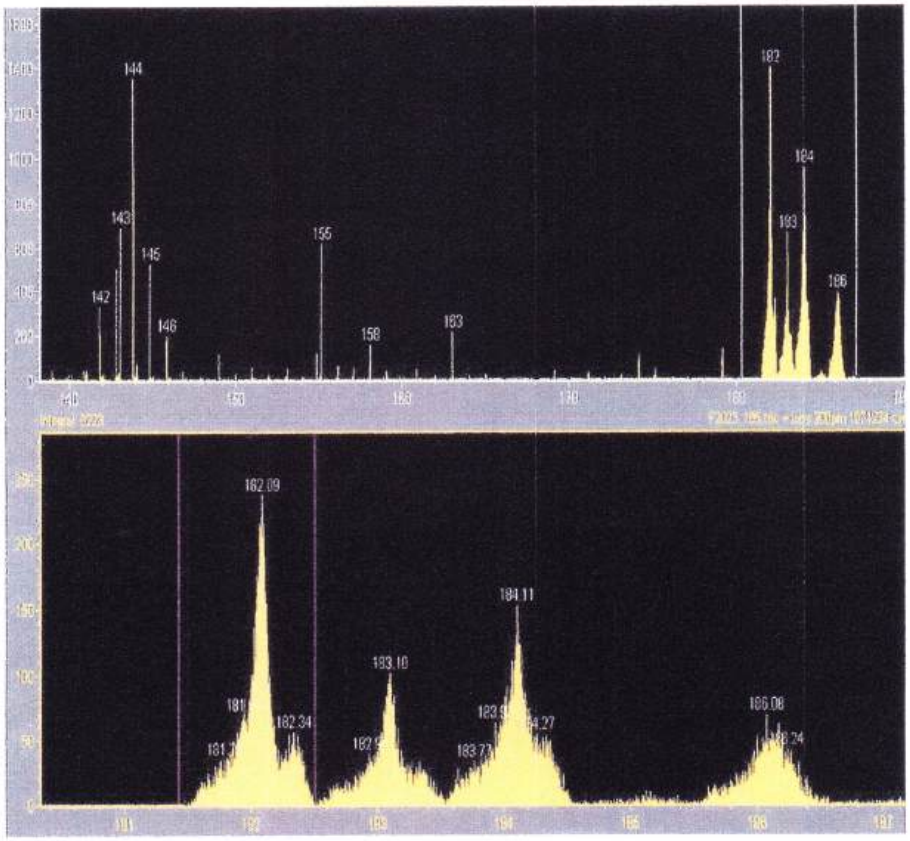

Fig. 3. Mass spectrum of modified tungsten in scrapings from the surface of a titanium anode.

From the data in Fig. 3 it is evident that the tungsten peaks are noticeably shifted from their natural positions towards larger masses, and are also very wide compared to the other peaks in the spectrum. For clarity, Fig. 4 shows the standard intensities and positions of the isotopes in the mass spectrum.

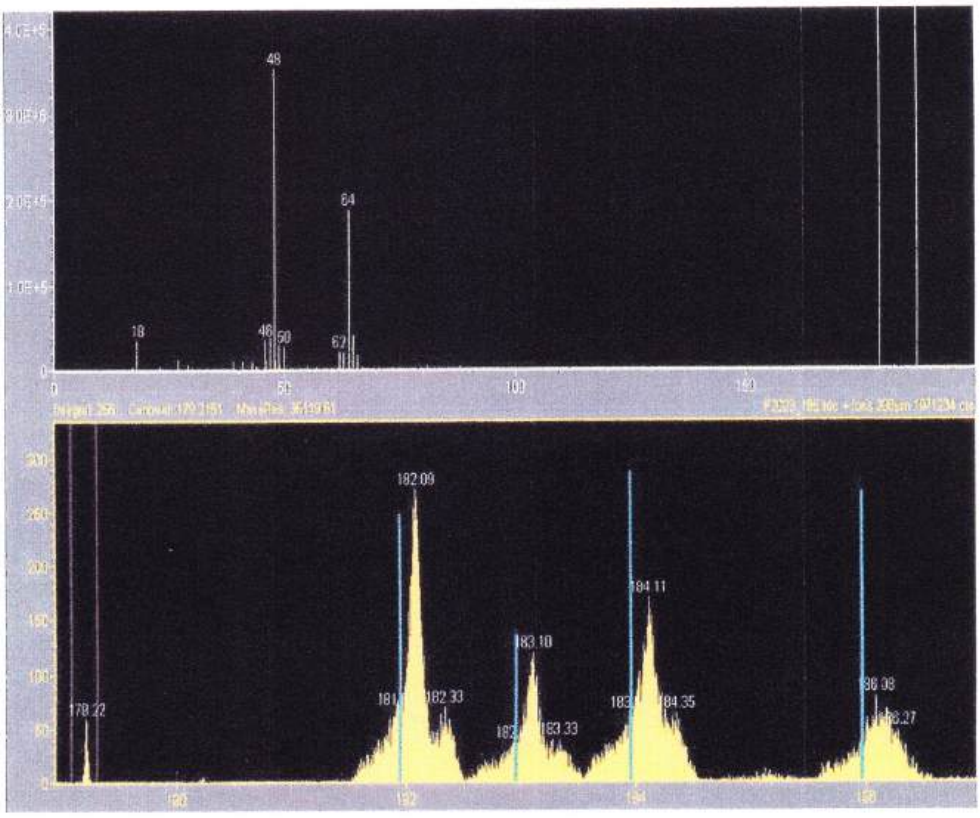

Fig. 4. Standard "natural" positions of tungsten isotopes in the mass spectrum (blue vertical lines), together with the actual signal.

The overall intensity of the tungsten signal is low, since tungsten is initially absent from the anode and flies in from the cathode during discharges. It is also worth noting the difference in the intensities of the isotopes of natural and modified tungsten. A typical spectrum of a tungsten cathode (a sample in the form of an electrode polishing), after conducting experiments with discharges and after short-term argon sputtering, is shown in Fig. 5. Note that the tungsten cathode contained an admixture of lanthanum

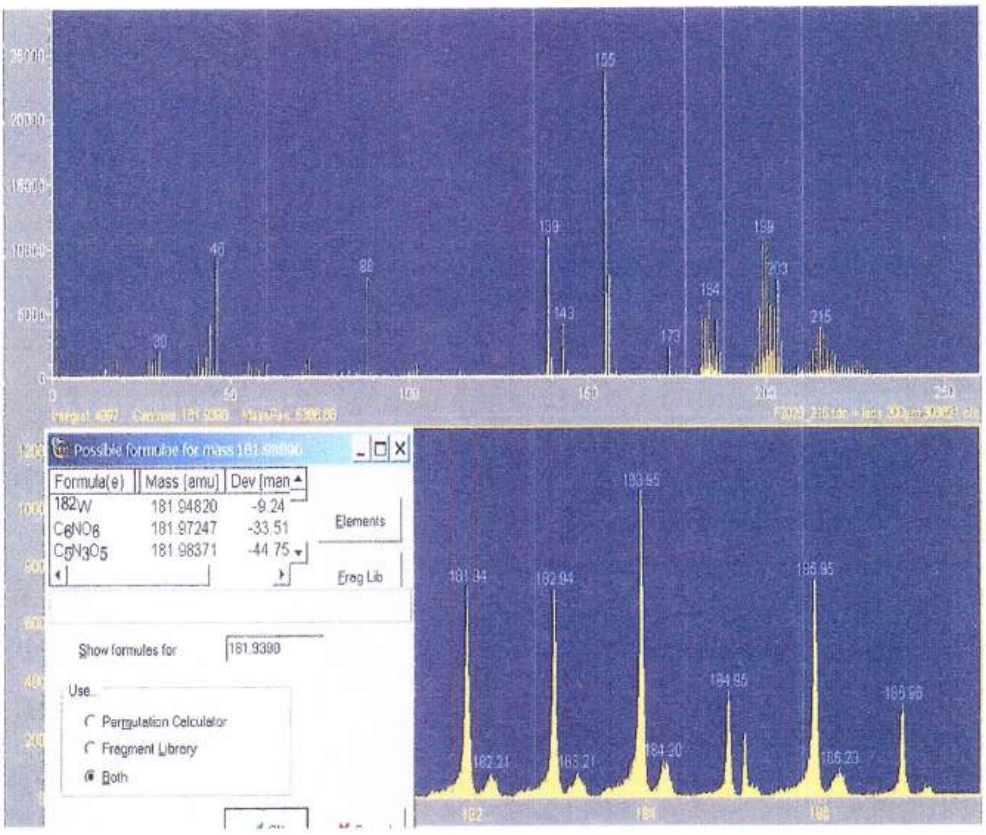

Fig. 5. Mass spectrum of a tungsten cathode. At the bottom is the mass region of tungsten isotopes, and the deviation of the ^{182}W peak from the standard position.

The spectrum in Fig. 5 was calibrated using hydrogen, lanthanum, and lanthanum oxide (139 and 155 masses). The deviations of the tungsten isotope positions from the reference values in the mass spectrum were less than 0.01 amu. Tungsten oxides are also clearly visible (a group of peaks at masses of ~ 200 and 216). WH hydrides are also visible (e.g., at 185 and 187 amu), which must be taken into account when determining the isotopic composition. Taking them into account, the isotopic composition can be considered natural (standard).

Discussion of results

First of all, we assume that the clearly expressed small "peaks" to the left of the main peaks in the lower part of Fig. 5 correspond to the masses m* of the modified atoms (containing (*ee*) – pairs) in contrast to the initial masses m of the tungsten atoms. The data in Table 1 correspond to one of the previously performed measurements and are close to the values indicated in Fig. 5.

The nature of the anomalous broadening to the left of the main peaks (see the lower part of Fig. 5) is due, according to [6], to small changes in the ion velocities that occur during the process of electrons escaping from the shell of an atom during the formation of a massive (*ee*) - pair in the shell. That is, this fact also indirectly testifies in favor of the existence of (*ee*) - pairs.

It should be noted that the anomalous shift (see Fig. 4) in the masses of tungsten atoms that reached the anode is not always observed. The use of copper or tantalum-based alloy as anodes was not accompanied by such an effect. With an aluminum anode, both normal and modified tungsten spectra were observed. Apparently, this effect is associated, on the one hand, with a decrease in the binding energy of modified tungsten atoms with the cathode (in accordance with the data in Table 2). On the other hand, the processes of bombardment of the cathode by atoms of the anode substance are also important. Moreover, first of all, the modified atoms of the anode will reach the cathode if the value of Q for them is less than that of the initial atoms of the anode. From the data of Table 3, in particular, it is clear that the values of Q for the mentioned metals differ.

Table 3. Molar heats of vaporization Q for a number of elements

Element Q (kJ/mol)	Al 284,1	Ti 422,6	Cu 304,6	Ta 758
Элемент* (n=1) Q (kJ/mol)	Al*→ Na 97,9	Ti*→Ca 153,6	Cu*→Co 389,1	Ta*→La 402

Элемент** (n=2) Q (kJ/mol)	Al**→ F 6,544	Ti**→A r 6,45	Cu**→M n 21	Ta**→C s 68.3

Thus, for Al* and Ti* atoms, the heat of evaporation is significantly less than for Cu* and Ta*. In addition, for more definite conclusions, control over the value of interelectrode distances and corresponding voltages is required.

It is natural to assume that the tungsten atoms with shifted masses on the titanium anode correspond to the small «peaks» of modified atoms W* in Fig. 5 and, with better resolution, the lower part of Fig. 4. In Fig. 6, part of Fig. 4 is presented with the inclusion of only four modified tungsten isotopes.

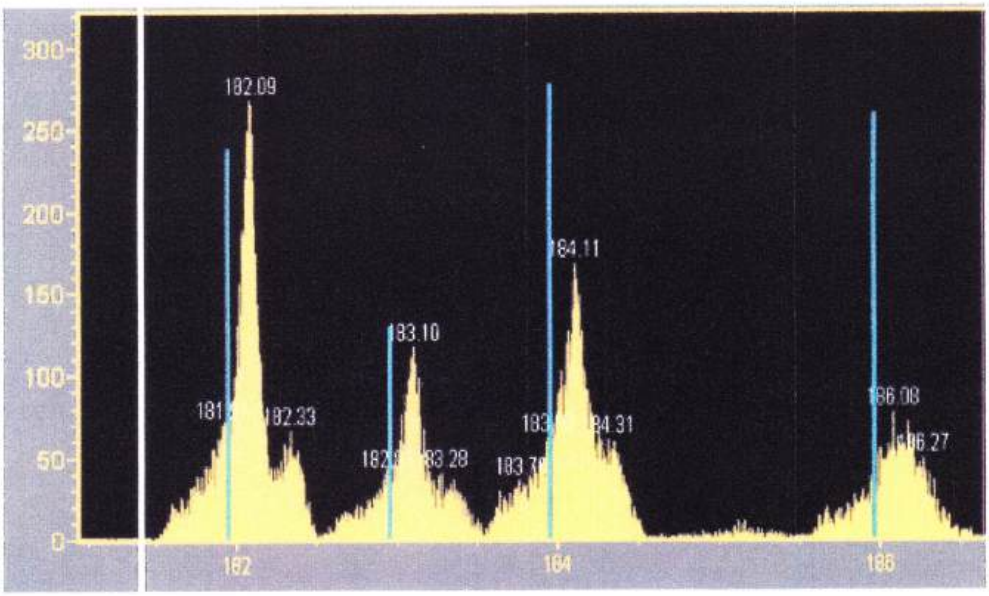

Fig. 6. Mass spectrum of tungsten isotopes W* on a titanium anode

The appearance of an additional small "peak" at 182.23 amu is noteworthy, which possibly corresponds to atoms with two (*ee*) - pairs. Similar mass spectrum inhomogeneities are present to a lesser extent in the vicinity of 183.28 amu and 184.28 amu. As can be seen from Fig. 6, sputtering for 30 seconds still preserves the above-mentioned spectrum inhomogeneities, but increasing the sputtering time by an order of magnitude practically eliminates them.

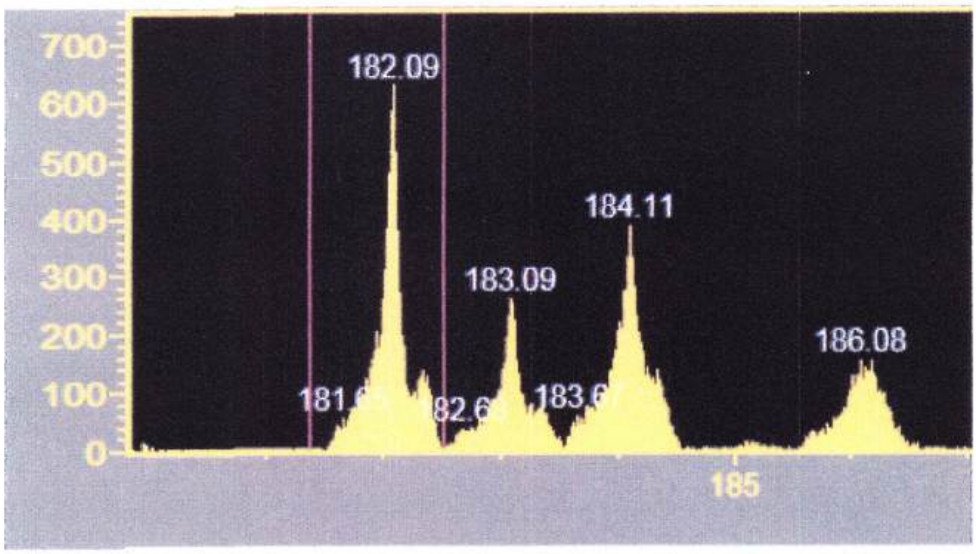

Fig. 7. Mass spectrum of tungsten isotopes W* on a titanium anode (after 30 sec of sputtering)

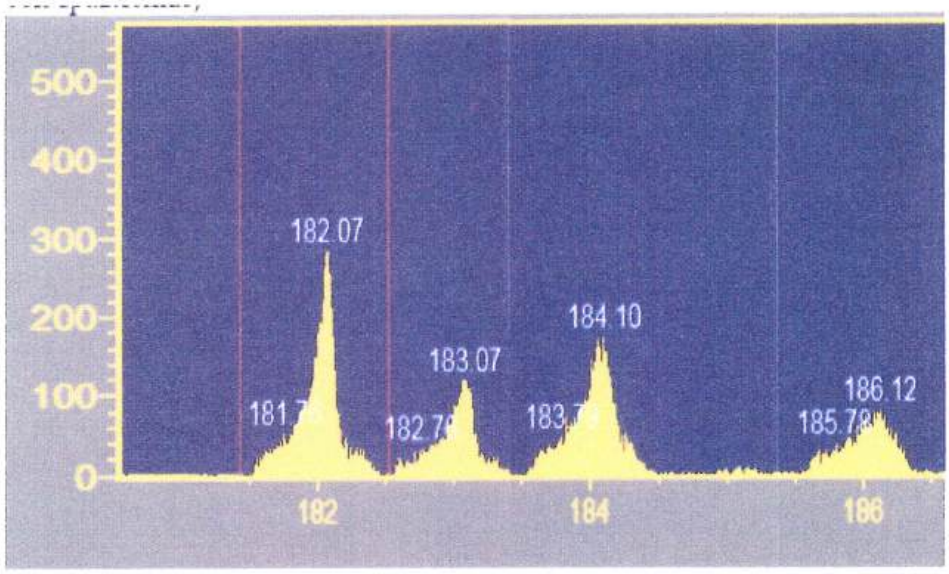

Fig. 8. Mass spectrum of tungsten isotopes W* on a titanium anode (after 300 sec sputtering)

Another remark concerns the question of the number of (*ee*) - pairs corresponding to the broadened small "peak". A comparative analysis of the mass spectra of titanium isotopes and their oxides [8] leads to the conclusion that each of the small "peaks" closest to the main peak on the right corresponds to atoms containing one (*ee*) - pair. The width of the small "peak" gives a spread in the mass values of individual (*ee*) - pairs. This conclusion is basically the same for tungsten isotopes, the examination of the mass spectra of whose oxides deserves a separate discussion.

The study of the mass spectra of atoms in the composition of scrapings from the cathode surface is also of interest.

The obtained results testify in favor of the existence of contact-bound massive electron pairs, which does not fit into the framework of quantum mechanics, but agrees with the conclusions of hadron mechanics, which takes into account the finite sizes of particles and generalizes quantum mechanics. The

authors interpret the modified atoms as atoms containing (*ee*)-pairs in deep orbits near the nucleus. However, according to the conclusions of hadron mechanics, a specific bound state of (*ee*)-pairs with protons is also admissible, leading to negatively charged pseudo-protons [3] and, accordingly, to pseudo-nuclei. Moreover, the neutron, in the spirit of Rutherford's idea, is considered as a bound state of an "isoproton" and an "isoelectron" [2]. The apparent contradiction with the bond imposed on the existence of such objects by the Heisenberg uncertainty relations is overcome in hadron mechanics by generalizing the uncertainty relations [9, 10] («isouncertainty» relations). Generalized uncertainty relations demonstrate an increase in the degree of determinism as the energy density of the medium increases. Thus, the experimental results indicating the appearance of modified atoms may also apply to the case of localization of (*ee*)-pairs in the region of nuclei (for example, in the composition of pseudoprotons).

Conclusion

The obtained experimental data testify in favor of the existence of massive electron pairs connected by contact interaction, as predicted by hadronic mechanics.

The emission of modified atoms from the surface of the tungsten cathode correlates well with the known fact of the appearance of "cathode spots" in local areas with increased current density.

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