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Spectrum of five times ionized tin (Sn VI) in the vacuum UV region

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Abstract. The spectrum of tin excited in a vacuum spark was recorded in the region 500 – 1500 Å on the 6.65 m normal incidence spectrograph. 110 lines of the $4d^85p$ – $4d^85d$ transitions in the Sn^{5+} ion in the region 680 – 850 Å have been identified and 52 energy levels of the $4d^85d$ configuration have been established.

Five times ionized tin, Sn VI, has the ground configuration $4d^9$. The resonance $4d^9$ - $4d^85p$ transitions and the transitions between the first excited configurations $4d^85s$ - $4d^85p$ have been studied previously [1,2]. After that, in our work [3] the transitions from higher excited configurations $4d^9$ - $4d^8(4f+6p)$ were added. As a result, the levels of the excited $4d^84f$, $4d^85s$, $4d^85p$ and $4d^86p$ were found. The only $4d^85d$ configuration of the n=5 sub shell was still unknown. In the present work the $4d^85p$ - $4d^85d$ transitions were studied and the levels of the $4d^85d$ configuration were located. This transition array is promising for a development of a radiation source in the ~ 800 Å region, which could be used for a molecular hydrogen dissociation in a problem of the optics cleaning in the lithography machines working with a tin radiation source on the 135 Å wavelength.

The spectra of tin were photographed on Ilford Q plates on a 6.65 m normal incidence spectrograph equipped with a 1200 l/mm grating. Excitation of the spectra was accomplished in a three-electrode vacuum spark with the parameters of discharge circuit: C = 10 μF, U = 3÷5 kV, L = 100÷500 нH. The discharge conditions were adjusted to have the high intensity of known Sn VI lines. Atomic calculations for the Sn^{5+} ion were performed using the Cowan code. In the first approximation the Hartree-Fock energy parameters of the $4d^85d$ configuration were scaled by the factors derived from the known $4d^95d$ configuration in Sn V. As new information on the $4d^85d$ levels becomes available the parameters were semi-empirically adjusted by a fitting to known energy levels resulting in more accurate spectrum prediction.

As a result, 110 lines of the $4d^85p$ – $4d^85d$ transitions in the region 680 – 850 Å were identified and 52 energy levels of the $4d^85d$ configuration were found in Sn^{5+}. After final fitting of the calculated to experimental level energies the wave functions in the intermediate coupling were obtained and used for the calculations of the transition probabilities. A comparison of the calculated transition probabilities (gA-values) with the observed line intensities of the $4d^85p$ – $4d^85d$ transitions is shown in Fig. 1.

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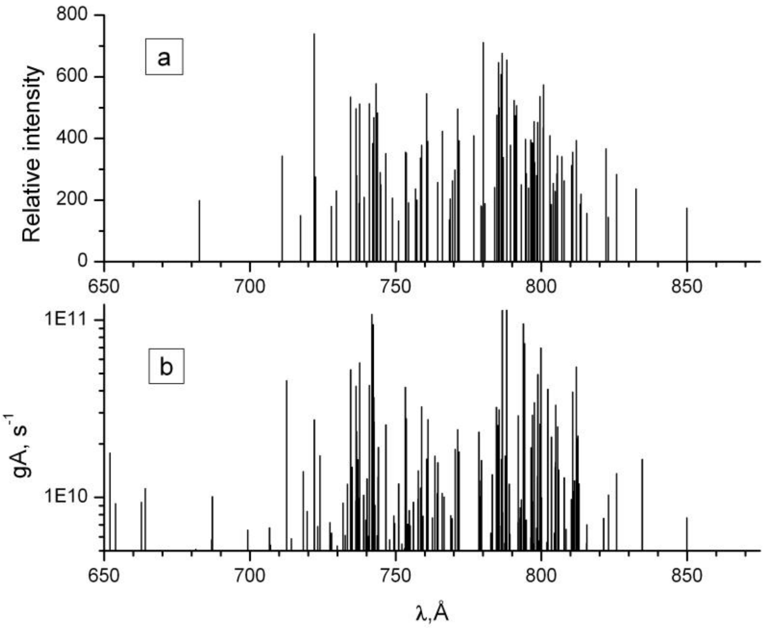

Fig. 1. Observed (a) and calculated (b) $4d^85p$ - $4d^85d$ transitions in the Sn^{5+} spectrum.

The agreement of the calculated transition probabilities with the line intensities is quite good taking into account nonlinearity of photographic response and possible blending of some lines. Thus, these atomic data can be helpful for plasma modelling in a development of the radiation source for ~ 800 Å region.

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