EXPERIMENTAL INVESTIGATION OF THE SURFACE TENSION OF RUBIDIUM AND CESIUM

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This article reports the results of measurements of the surface tension of rubidium and cesium at temperatures of up to 1150°K. The measurements (done for the first time in the case of rubidium) were carried out on an automatic experimental apparatus described in [1]. It was established that the temperature dependence of the surface tension is nonlinear.

The force pulling a plate into the liquid studied was determined with an automatic microanalytical balance. Certain changes in the experimental technique used in [1] made it possible to reduce the scatter of the experimental results.

Firstly, all the measurements were taken under receding contact angle conditions.

Secondly, the plate pulled out of the liquid metal was weighed before each measurement of the surface tension. This made it possible to check the stability of the zero position of the balance and to make corrections for the weight of metal droplets condensed on the suspending wires.

Thirdly, the pulling force at each experimental temperature was measured with the plate immersed in the liquid metal at two different levels, the usual depths of immersion being l = 0 and 3 mm.

As in previous experiments, the apparatus was evacuated and then filled with pure helium. The liquid metal, before being fed into the batcher, was passed through a porous stainless steel filter to remove the oxides. All the parts in contact with liquid metals were made of type 1Kh18N9T stainless steel. The weight of the plate was found to be the same before and after the experiments.

The measurements were carried out on technical grade rubidium RETU-118-59 (containing 89% Rb and the following major impurities: 9% K, 0.1% Na, 0.1% Ca and 1.0% Cs) in pure helium at a pressure of 4.5 atm. A plate measuring 1.477 × 2.25 × 0.01 cm and a tube with o. d. = 1.825 cm and wall thickness δ = 0.0167 cm were used as the working element. Preliminary tests in octane showed that comparable results were obtained with plates of various sizes and with the tube. In tests with rubidium the metal was cooled several times below its freezing point. The results of the measurements (dyne/cm) at various temperatures are reproduced in Tables 1 and 2 and in a figure (curves 1 and 2) relating to rubidium and cesium, respectively, and the broken curve representing the results obtained in [2]).

As shown in Figure 1, the surface tension at temperatures of up to 630°K varies linearly with temperature. At higher temperatures the curve dips, although the interpolated relationship still remains linear. The constants of interpolation formulas and the corresponding temperature intervals are given in Table 3. The mean deviation from interpolated straight lines is 0.7%.

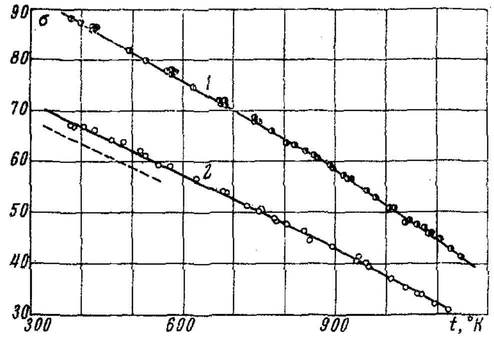

Fig. 1

Grade RETU-117-59 cesium used in the experiments contained 98% Cs and the following impurities: 0.5% K, 1.0% Rb, 0.05% Na and 0.1% Ca. The experimental technique was the same as for rubidium.

The results are reproduced in tables and in a figure where the broken curve represents the results obtained in [2] for pure cesium by determining the maximum pressure in a bubble. Our results are about 5% higher, which is easily explained by different purities of the metals studied. However, the temperature coefficients of the surface tension are practically identical. (This point should be stressed since it points to a possibility of carrying out relative measurements on not quite pure

Table 1

T° K	σ	T° K	σ	T° K	σ	T° K	σ
			Rubidium				
376.1	88.32	670.0	71.66	865.2	58.48	1012.8	50.92
396.2	87.50	674.3	71.35	888.8	59.30	1035.4	48.25
420.6	85.64	681.0	70.96	890.0	59.07	1041.8	48.48
420.9	86.49	719.8	67.88	913.3	57.54	1058.6	47.89
428.8	86.58	747.0	67.60	918.2	56.58	1071.9	47.05
491.2	82.02	772.7	65.83	922·5	56.58	1079.3	45.85
527.2	79.80	799.1	63.65	927.0	56.64	1085.4	45.79
568.8	77.68	817.3	63.08	934·3	54.43	1103.9	44.75
573.2	77.23	837.8	62.03	959.2	54.05	1122.2	42.78
582.7	77.32	855.2	61.32	974.9	53.12	1142.4	41.45
617.0	74.56	864.3	61.02	1000.8	50.90		
			Cesium				
376.5	67.34	526.3	61.34	782.9	48.95	967.9	39.32
383.0	67.09	575.6	59.00	785.5	48.28	1011.4	37.34
402.6	66.75	627.7	56.95	805.5	47.62	1038.7	35.37
424.4	66.28	680.1	54.19	840.3	46.27	1060.7	34.05
456.9	64.40	686.7	53.93	895.7	43.28	1069.0	34.04
479.8	63.58	729.0	51.25	945.3	40.97	1098.4	32·08
515.4	62.00	749.9	50.27	947.7	41.26	1099.7	32.08
515.4	62.00	756.1	50.26	964.4	39.99	1124.6	31.07

Table 2

T° K	σ_{Cs}	σ_{Rb}	T° K	σ_{Cs}	σ_{Rb}
350	691	90.4	750	50.5	66.9
400	66.8	87.5	800	48.1	63.9
450	64.6	84.6	850	45.6	61.0
500	62.4	81.6	900	43.2	58.0
550	60.1	78.7	950	40.4	54.8
600	57.8	75.7	1000	37.8	51.4
650	55.4	72.8	1050	35.1	48.0
700	53.0	69.8	1100	32.4	44.6
			1150	29.7	41.2

metals.) As in the case of rubidium, the temperature dependence of the surface tension of cesium is not linear, being represented by three linear segments. The mean deviation of the experimental points from interpolated straight lines is 0.61%.

Table 3

	a	b	ΔT
Rb	92.75	0.059	311.2—950
	98.20	0.068	950—1150
Cs	71.3	0.045	301.7—570
	72.5	0.049	570—930
	75.5	0.054	930—1150

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REFERENCES

1. A. A. Kiriyanenko, O. P. Makarova, V. D. Romanov, and A. N. Solov'ev, "Experimental determination of the surface tension of liquid sodium," PMTF [Journal of Applied Mechanics and Technical Physics], no. 4, 1965.

2. O. A. Timofeevicheva, V. B. Lazarev and A. V. Pershikov, "Surface tension of liquid cesium," Dokl. AN SSSR, vol. 143, no. 3, 1962.

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