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MECHANICAL PROPERITES OF ALUMINUM, COPPER, TIN AND CADMIUM BASE MULTILAYER COMPOSITIONS

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327-72

MECHANICAL PROPERTIES OF ALUMINUM, COPPER TIN AND CADMIUM BASE MULTILAYER COMPOSITIONS

V. S. Kopan' and A. V. Lysenko

Reasons for improving the mechanical properties of metallic films and fibers in flaky compositions are brought to light in [1, 2]. In [3], the mechanical properties of multilayered compositions, obtained using a method of vacuum evaporation, are investigated. In this work, substantial durabilities in a rupture of flaky samples, obtained using a method of cold weld with a lamination of a pile of foil, are considered. The average thickness of layer h in multilayered compositions varied from 4 mk to 200Å. To avoid the effect of scale factors during mechanical testing, the experiments were conducted on samples of equal thickness; therefore, the number of layers in a sample sometimes reached 12,000. In the multilayer compositions, an aluminum layer was alternated with copper (relative thickness of layers--h_{Cu}/h_{Al}= 1.4), cadmium (H_{Cd}/h_{Al}=0.3) or tin (h_{Sn}/h_{Al}=1).

The durability of the flaky samples to a rupture grew quickly with an increase of layer thickness to 200 Å, reaching 90 kg/mm^2 for Al-Cu ; 27 kg/mm^2 for Al-Cd and 23 kg/mm^2 for Al-Sn (see the figure; each point is the average of tests of 15-20 samples). With the addition of flakes, the durability of deformed foils considering the percent composition of multilayered compositions of the value of durability would form only 26, 10 and 7 kg/mm^2, respectively.

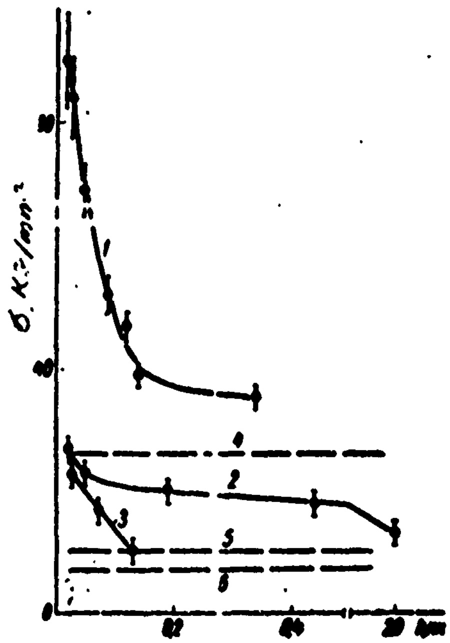
In the table, tension values (kg/mm^2) of split diffusion from one layer to another σ_1 are presented [4] along with the split diffusion tension in the outer layers σ_2 [4] and tension σ_3, which are necessary for dislocation motion in multilayered compositions, formed from layers of equal thickness. Values of σ are calculated according to formulas (1)-(3) of [2, 4]:

$$\sigma_1 = 6,8\,(E\gamma/h)^{1/2}; \qquad (1)$$

$$\sigma_2 = 0,35\sigma_1, \qquad (2)$$

$$\sigma_3 = Gb/h, \qquad (3)$$

where E, G are moduli of resiliency and shearing; γ is surface energy; b is Byurgers vector.



Dependence of durability to rupture of multilayered compositions from average layer thickness:
1, 4--Al--Cu; 2, 5--Al--Cd; 3, 6--Al--Sn (--- with the addition of durability building layers.

Formula (2) is truc in the case when the Pauasson coefficient for the four mentioned metals is 0.3. During calculation, the following values of the parameters were used (for Al, Cd, Sn, Cu respectively): $E = (7.1; 5; 4.5; 13) \cdot 10^{11}$ din/cm^2; $G = (2.6; 1.9; 2.3; 4.5) \cdot 10^{11}$ din/cm^2; γ = 840, 630, 540, 1800 erg/cm^2; $b = 3 \cdot 10^{-8}$ cm.

h, Å	Al			Cu			Cd			Sn		
	σ_1	σ_2	σ_3	σ_1	σ_2	σ_3	σ_1	σ_2	σ_3	σ_1	σ_2	σ_3
100	1700	600	80	3300	1100	150	1200	420	60	1000	350	70
200	1200	420	40	2300	810	70	900	320	30	700	250	30
500	760	270	16	1500	530	29	550	190	12	450	160	13
2500	340	120	3	650	230	6	250	90	2	200	70	2,5
4 мк	85	30	0,2	160	56	0,4	60	21	0,1	50	20	0,2

As is apparent from the table, the strengthening of multilayered compositions at the expense of tapering of the layers is significant when $h < 1$mk, which agrees with the information of the figure.

However, peak values of durability are of less value according to formulas (1)-(3). Experiments for determining the specific electrical resistance of multilayered compositions depending on the thickness of the layers indicated that when $h < 500$Å, the layers in the rolling process are ruptured at the scales and in subsequent action are deformed without tapering. It is probably possible to explain this by the fact that two to three fold strengthening is obtained for all multilayer compositions.

Measuring of the specific electrical resistance has shown that the concentration of admixture in layers (for example, in copper--aluminum admixture, and in aluminum--copper) at the expense of some solubility of the layers is less than 0.2 at. %.

In conclusion, we express our gratitude to P. P. Kuz'menko for his active help and support in the implementation of the work.

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