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COPPER-BASE ALLOY CONTAINING TITANIUM AND ANTIMONY

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ABSTRACT OF THE DISCLOSURE

Disclosed are alloy compositions consisting essentially of copper and small amounts of titanium and antimony within stated ranges. These compositions have high electrical conductivity, high strength and high ductility as compared with copper alloys containing either titanium or antimony. The disclosed ranges of alloy compositions provide a class of copper-base alloys having a unique flexibility with regard to electrical, mechanical and physical properties. By varying the relative and total amounts of titanium and antimony, copper-base alloys having predictable and differing properties may be obtained. Methods for the heat treatment and fabrication of the alloys are also disclosed.

This is a division of application Ser. No. 292,186, filed Sept. 25, 1972, now U.S. Pat. 3,773,505.

The invention relates to copper-base alloys that are particularly useful as conductors in applications requiring greater tensile strength or greater ductility at a given tensile strength than possessed by pure copper.

Copper-base alloys, that is, alloys wherein copper is the predominant component, containing both titanium and antimony have not been found in the literature. Copper-titanium alloys and alloys having copper and titanium with lead, tin or zinc are known. See U.S. Pats. Nos. 2,616,800 and 935,863, respectively.

This invention relates to copper-base alloy compositions, and more particularly to copper-base alloy compositions containing small amounts of titanium and antimony within stated ranges.

It is an object of this invention to provide a class of copper base alloy compositions wherein the electrical, mechanical and physical properties of copper may be predictably modified by altering the relative and total concentration of titanium and antimony, the alloying elements.

It is a further object of this invention to provide copper-base alloys possessing high electrical conductivity, high strength and high ductility, as compared with copper-base alloys containing either titanium or antimony.

It is a further object of this invention to provide methods for the heat treatment and fabrication of the copper-base alloys disclosed.

The class of copper-base alloys of the present invention consists essentially of titanium, antimony and a copper base, the titanium being present in an amount from about 0.08 to about 0.7 weight percent and the antimony from about 0.05 to about 1 weight percent.

Pure copper (Copper Development Association Copper No. 102) in spring temper characteristically possesses an IACS (International Annealed Copper Standard) conductivity of 101 percent and a UTS (ultimate tensile strength) of 55,000 p.s.i. with a ductility of four percent elongation in two inches, while certain compositions of the class of copper alloys of this invention possess, when properly processed, electrical conductivities in excess of 85 percent IACS and tensile strengths of over 60,000

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p.s.i. with ductilities greater than 12 percent elongation in two inches. Other compositions possess electrical conductivities in excess of 75 percent IACS and tensile strengths of over 80,000 p.s.i. with ductilities greater than eight percent elongation in two inches.

The alteration in the electrical, mechanical, and physical properties of the copper-base alloys is attained by varying the relative and total amounts of the alloying elements, titanium and antimony. The effects of these variances are shown in Table I. (The tables herein report only the titanium and antimony content. It should be understood that the balance of the alloy composition is essentially copper. Throughout the specification RT=reduction in thickness, YS=yield strength, and R_B=Rockwell "B" method.)

TABLE I

Properties of Cu-Fi-Sb alloys

Cold rolled 75% RT, aged at 800° F. for 2 hrs.

Cold rolled 60% RT, re-aged at 700° F. for 1 hr.

Composition, wt. percent		Electrical conductivity (percent IACS)	Tensile properties		
Ti	Sb		UTS (p.s.i.)	YS at 0.5% extension (p.s.i.)	Percent elongation in 2 inches
.13	0.5	73	61,000	60,000	9
.086	.10	89	56,800	51,800	13
.12	.13	86	61,000	----------	15
.12	.15	86	62,000	----------	13
.12	.16	86	64,000	62,200	14
.10	.15	86	62,500	----------	12
.09	.14	89	56,000	----------	16
.066	.11	89	48,800	39,000	20
.10	.17	87	62,000	58,200	11
.12	.20	84	63,700	59,800	12
.10	.25	82	66,300	62,900	12
.11	.33	74	56,800	50,200	13
.11	.72	57	63,300	----------	16
.10	1.36	39	59,200	----------	23
.16	.01	70	59,500	58,000	9
.15	.10	85	64,000	60,500	12
.16	.17	85	63,500	60,700	8
.14	.19	85	68,400	65,400	11
.25	.26	80	74,000	71,000	9
.22	.25	80	73,500	----------	10
.23	.28	79	74,000	----------	10
.21	.29	80	74,000	71,600	15
.22	.32	81	74,500	----------	10
.23	.36	80	76,000	----------	10
.22	.37	76	76,000	73,900	10
.24	1.36	43	69,500	55,500	14
.33	.37	71	78,500	----------	10
.31	.39	75	80,000	----------	10
.31	.43	75	80,500	78,600	13
.31	.44	76	79,500	----------	10
.32	.49	76	81,000	79,000	8
.33	.56	76	80,000	78,400	10
.36	.62	69	86,100	83,000	9
.34	.64	69	86,100	83,700	8
.42	.23	45	80,700	----------	7
.44	.52	67	84,500	----------	10
.42	.53	68	82,500	----------	10
.42	.58	75	79,000	77,800	15
.43	.63	74	82,000	----------	10
.41	.64	75	79,000	----------	10
.43	.72	66	85,000	83,500	8
.44	1.35	52	74,500	68,400	12
.48	.10	33	75,400	72,200	7
.48	.56	65	81,000	78,900	7
.55	.62	64	84,500	82,800	8
.50	.64	68	85,500	84,000	8
.49	.67	71	82,500	80,300	8
.52	.76	73	81,500	79,800	8
.50	.80	69	85,500	84,200	8
.49	.82	71	85,000	83,500	8
.69	1.06	70	80,700	78,000	9

As the data of Table I demonstrate, the electrical conductivity of the copper-base alloys decreases with increasing titanium content, and the ultimate tensile strength increases. The data also illustrate that for any given titanium content, a greater value of electrical conductivity is achieved by maintaining the amount of anti-