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3,438,771
EXTRUDED ARTICLE OF MAGNESIUM-BASE ALLOY

Peter F. King, Farmington, Mich., assignor to The Dow Chemical Company, Midland, Mich., a corporation of Delaware

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7 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to an extruded article formed of magnesium-base alloy and more particularly relates to an improved magnesium-base alloy extrusion containing silicon and zinc.

The magnesium-zinc-silicon alloys containing up to 1.5 percent of zinc and up to 2 percent of silicon are readily extruded at speeds up to 100 feet per minute as disclosed in U.S. Patent 3,067,028. These alloys, when iron is present as an impurity, suffer from rather high salt water corrosion rates.

It is a principal object of the present invention to provide an extruded article formed of magnesium-base alloy containing zinc, silicon and iron and having substantial resistance to salt water corrosion.

This and other objects and advantages of the present invention will be more clearly understood by those skilled in the art upon becoming familiar with the following description and the illustrative examples.

It is now been discovered that substantial resistance to salt water corrosion is exhibited by an extruded article formed of magnesium-base alloy comprising by weight from 1.7 to 2.5 percent of zinc, from 0.5 to 1.5 percent of silicon, from 0.012 to about 0.05 percent of iron present as an impurity and the balance substantially magnesium, the ratio of the weight percent of zinc to the weight percent of silicon being not less than about 1.667 and the aluminum and manganese contents of the alloy not exceeding about 0.2 percent by weight and 0.05 percent by weight, respectively. Preferably the zinc content of the alloy employed is in the range of 1.7 to 2.2 percent by weight, while the silicon content is preferably 0.5 to 1.32 percent. More preferably the silicon content is in the range of 0.7 to 0.9 percent. The most preferred zinc to silicon weight ratio is about 2.5.

Higher zinc leads to hot shorting and edge cracking which limit extrusion speeds. Higher silicon increases corrosion rates. Lower zinc and lower silicon cause decreased mechanical properties. Lower zinc also decreases resistance of the alloy to corrosion.

It is highly desirable that the iron content of the alloy is in the range of 0.012 to 0.03 percent by weight. It is also to be preferred that the aluminum and manganese contents of the alloy do not exceed those of commercially pure magnesium. Commercially pure magnesium obtained from electrolytic cells contains less than about

0.03 percent by weight of aluminum and less than about 0.01 percent by weight of manganese.

The extruded article of the invention is further characterized by a salt water corrosion rate lower than about 1 milligram per square centimeter per day when tested by a standard alternate immersion method described herein-after. The article of the present invention is of special advantage because it can be prepared from magnesium-zinc-silicon alloy prepared using ferrosilicon as the source of silicon whereby ordinarily a small amount of iron is retained in the alloy. The alloy is readily extruded at speeds of 50 feet per minute and as high as 100 feet per minute substantially without adverse effects on mechanical properties and resistance to corrosion.

The alloy of the invention is readily prepared according to methods well understood in the magnesium metal art. Magnesium is melted under a conventional flux cover and the requisite amount of zinc and silicon, or ferrosilicon, is added to the melt while the melt is at a temperature of about 1600° F. In the event ferrosilicon is employed, most of the iron, which is sparingly soluble in molten magnesium, normally precipitates into the bottom sludge layer of the melt. While the zinc may be added to the melt at any time, if ferrosilicon is the source of silicon, the requisite amount of zinc is added to the melt as metallic zinc after the iron settles out.

After the addition of the alloying components, the melt is brought to casting temperatures, usually in the range of 1,250 to 1,450° F., and cast into billets suitable for extrusion stock.

The following examples are presented to illustrate the invention and not to limit the scope thereof.

Examples

In accordance with the present invention, a series of magnesium-zinc-silicon alloys were prepared by alloying together the requisite proportions of magnesium, silicon and zinc. The resulting alloys were each cast as 3" diameter billets. The cooled solidified billets were scalped, heated to about 925° F., placed in a preheated ram extrusion press, and extruded into 3/4" x 1/16" strip at a temperature of about 900° F. and at a speed of about 100 feet per minute. Coupons were cut from the resulting strip and subjected to testing to determine physical properties of the extruded metal. Additional coupons were subjected to a standard alternate immersion test in which the coupon is immersed for 30 seconds in 3 percent aqueous sodium chloride solution maintained at 95° F. and suspended in air 90 seconds before again immersing the coupon for 30 seconds and so on cyclically. Prior to the corrosion tests each coupon was immersed in an acetic acid-sodium nitrate pickle long enough to remove 0.001 inch (1 mil) of metal from each of the coupons. At the conclusion of the corrosion test, metal loss was determined and calculated as milligrams corrosion loss per square centimeter of surface area per day (m./c./d.). The compositions of the alloys prepared and tested, the corrosion rates and the physical properties are summarized in the following table.

Run No.	Composition, percent by weight ¹					Zn/Si ratio	Extrusion speed, feet per minute	Corrosion rate, M/C/D	Physical properties			
	Zn	Si	Fe	Mn	Al				Percent E	TYS	CYS	TS
1.....	2.37	0.81	0.021	0.01	0.03	2.9	100	0.61	11	24	14	36
2.....	2.42	.86	.015	.01	.03	2.8	100	.65	14	24	14	36
3.....	2.38	.82	.017	.048	.03	2.9	100	.69	9	24	13	33
4.....	2.29	.85	.021	.01	.052	2.7	100	.86	10	-----	14	35
5.....	2.38	.84	.022	.01	.03	2.8	100	.93	11	25	14	36
6.....	2.39	.88	.022	.01	.20	2.7	100	1.0	10	24	14	36
Comparison ²	1	-----	-----	0.2	3	-----	50	.64	14	25	12	35

¹ Balance magnesium.

² Composition values are nominal for the commercial alloy AZ31B. Percent E = Percent elongation in 2 inches. TYS = Tensile yield strength

in thousands of pounds per square inch. CYS = Compression yield strength in thousands of pounds per square inch. TS = Ultimate tensile strength in thousands of pounds per square inch.

By way of comparison an extrusion formed of the conventional alloy AZ31B was similarly prepared and tested except that extrusion was carried out at a rate of 50 feet per minute. The corrosion rate and the physical properties for the extrusion of AZ31B are also listed in the table. The results show that the physical properties and the corrosion rates of the samples of the present extruded article obtained at a high extrusion speed are comparable to the properties of the widely used conventional alloy AZ31B. It was unexpected that such properties are attained in a low cost alloy which has been extruded at high extrusion rates of 50 to 100 feet per minute.

The extruded article of the invention having been thus fully disclosed various modifications thereof will at once be apparent to those skilled in the art and the scope of the invention is to be considered limited only by the breadth of the claims hereafter appended.

I claim:

1. An extruded article formed of magnesium-base alloy comprising by weight from 1.7 to 2.5 percent of zinc, from 0.5 to 1.5 percent of silicon, from 0.012 to about 0.05 percent of iron present as an impurity and the balance magnesium, the ratio of the weight percent of zinc to the weight percent of silicon being not less than about 1.667, the aluminum content of the alloy not exceeding about 0.2 percent by weight, the manganese content of the alloy not exceeding about 0.05 percent by weight and the extruded article being further characterized by a salt water corrosion rate lower than about 1 milligram per square centimeter per day, as determined by a standard alternate immersion test in 3 percent aqueous sodium chloride solution.

2. The extruded article as in claim 1 which has been made by extruding the said composition at a speed in the range of 50 to about 100 feet per minute.

3. The extruded article as in claim 1 in which the zinc content of the magnesium-base alloy is in the range of 1.7 to 2.2 percent and the silicon content is in the range of 0.5 to 1.32 percent.

4. The extruded article as in claim 1 in which the zinc content of the magnesium-base alloy is in the range of 1.7 to 2.2 percent and the silicon content is in the range of 0.7 to 0.9 percent.

5. The extruded article as in claim 1 in which the iron content of the magnesium-base alloy is in the range of 0.012 to 0.03 percent.

6. The extruded article as in claim 1 in which the ratio of the weight percent of zinc to the weight percent of silicon in the magnesium-base alloy is about 2.5.

7. The extruded article as in claim 1 in which the aluminum and manganese contents of the magnesium-base alloy do not exceed that of commercially pure magnesium.

References Cited

UNITED STATES PATENTS

3,067,028	12/1962	Foerster	75—168
3,119,684	1/1964	Foerster	75—168 X
3,240,593	3/1966	Schneider et al.	75—168

FOREIGN PATENTS

40,937	10/1929	Denmark.
1,954	11/1963	Japan.

CHARLES N. LOVELL, *Primary Examiner.*