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DUCTILE RUTHENIUM ALLOY AND PROCESS FOR PRODUCING THE SAME

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8 Claims. (Cl. 29—182)

ABSTRACT OF THE DISCLOSURE

The ductility of ruthenium produced by powder metallurgy is improved by mixing ruthenium powder with 0.1% to 25% of rhenium powder and consolidating the mixture to form an alloy product.

The present invention is directed to a process for producing by powder metallurgy methods a ruthenium product characterized by improved ductility and to the ruthenium product produced by the said process.

Ruthenium is a refractory metal normally produced as a powder by the reduction of a salt or compound of the element. When the metal is required in a consolidated form, the powder may be melted and cast or may be compacted and sintered by conventional powder metallurgical techniques. By whichever method the consolidation is effected, the resultant metal is not readily workable.

We have now discovered a means whereby the ductility of a ruthenium product produced by powder metallurgy can be susbtantially increased.

It is an object of the present invention to provide a powder metallurgy method whereby the ductility of ruthenium is substantially improved.

It is a further object of the invention to provide a method employing commercially available materials to produce by powder metallurgy ruthenium products having improved ductility.

It is another object of the invention to provide ruthenium powder metallurgy products characterized by improved ductility.

Other objects and advantages of the invention will become apparent from the following description.

According to this invention, ruthenium produced by powder metallurgical methods is alloyed with a lesser amount of rhenium and it is found that the resultant alloy has much improved ductility. This is very surprising since if ruthenium is alloyed with rhenium by melting, no improvement in ductility is obtained, although there is some decrease in hardness when the amount of rhenium added is small. Again, if zinc, for example, is added to ruthenium by melting, there is some improvement in ductility but none is obtained if zinc is added to powder metallurgically produced ruthenium.

As little as 0.1% rhenium improves the ductility of ruthenium but, advantageously, about 0.25% to about 2.5% of rhenium is employed. Substantially greater amounts of rhenium, say 10% or even 25%, can be included in the alloy if desired. A further advantage of the alloys of the invention lies in the fact that they increase in ductility after recrystallization.

In producing the alloys, ruthenium powder and rhenium powder may be thoroughly mixed and pressed to compacts in flexible bags under a pressure of, say, 8 to 10 tons per square inch. The resultant compacts may be sintered, for instance at 1450° C. for 8 hours in vacuo, and hot rolled at the sintering temperature to sheet. The

thickness may be reduced by 3% at each pass. Sheets of different rhenium content made in this way and each 0.02 inch thick were vacuum annealed at 1450° C. for 8 hours, and then subjected to tensile tests and to bending tests on a Galileo Rigidometer. The results obtained were as follows:

Alloy	Ultimate Tensile Strength [1]	Bend Test [2] (degrees)
Pure Ru		0.8–7
0.5% Re, balance Ru	20	20
2.0% Re, balance Ru	22	15
10.0% Re, balance Ru	26.8	17
20.0% Re, balance Ru	26.1	12

[1] Tons per square inch.
[2] Angle of plastic deformation before cracking (span length=10 mm.).

The results of bend ttests on apparently identical samples of pure ruthenium vary unaccountably within the range given above. Generally speaking, the angle of plastic deformation does not exceed 2° and values as high as 5° or 7° are obtained only exceptionally.

The alloys according to the invention consist simply of ruthenium and rhenium except for any impurities which may be present. Commercially available powders may be employed to produce the special products contemplated in accordance with the invention.

The ductility of the alloys according to the invention is such that they can be used as sparking plug electrodes, since they can be readily bent to adjust the size of the spark gap in the sparking plug. Moreover, the alloys according to the invention have better resistance to attack by lead than has iridium, commonly used as such an electrode.

The alloys are also useful for the construction of other articles and parts that require great resistance to corrosion and are made by hot or cold forming. Examples of such articles are crucibles for handling compounds containing phosphorus, repair plugs for glass lined vessels for handling corrosive materials, and facings for soldering iron bits. In the last mentioned use, the combined properties of resistance to oxidation and resistance to attack by molten metal are of particular advantage.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

We claim:

1. The process for improving the ductility of ruthenium which comprises mixing ruthenium powder with rhenium powder to produce a powder mixture containing about 0.1% to about 25% by weight of rhenium, with the balance essentially ruthenium, compacting and sintering said powder mixture to form a consolidated ruthenium product and hot working said consolidated product to form a ruthenium shape having improved ductility as compared to a similar ruthenium shape produced from ruthenium powder alone.

2. The process according to claim 1 wherein the initial powder mixture contains about 0.1% to about 20% rhenium powder.

3. The process according to claim 1 wherein the initial powder mixture contains about 0.1% to about 10% rhenium powder.

4. The process according to claim 1 wherein the initial powder mixture contains about 0.25% to about 10% rhenium powder.

5. The process according to claim 1 wherein the initial powder mixture contains about 0.25% to about 2.5% rhenium powder.

6. A ruthenium alloy powder metallurgy product having improved ductility and containing about 0.25% to about 2.5% by weight of rhenium with the balance being essentially ruthenium.

7. A ruthenium alloy powder metallurgy product having improved ductility and containing about 0.1% to about 25% by weight of rhenium with the balance being essentially ruthenium.

8. A ruthenium alloy powder metallurgy product having improved ductility and containing about 0.25% to about 10% by weight of rhenium with the balance being essentially ruthenium.

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CERTIFICATE OF CORRECTION

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Bryan Jones et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, line 10, after "19,959/64" insert -- , Complete specification, Apr. 29, 1965 --; column 2, line 19, for "ttests" read -- tests --.

Signed and sealed this 18th day of February 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents