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(54) Titre : UTILISATION D'UN ALLIAGE TUNGSTENE/METAL LOURD

(54) Title: USE OF A TUNGSTEN/HEAVY METAL ALLOY

(57) **Abrégé/Abstract:**

The invention relates to the use of a tungsten/heavy metal alloy for tools such as extrusion dies and extrusion mandrels for the hot-forming of copper and copper alloys. The alloy consists of 80 to 89.9% by weight of tungsten, 2 to 7% by weight of chromium, remainder binder metal. The use of this alloy primarily results in a considerably reduced formation of grooves on the surface of the forming tools.



Abstract

The invention relates to the use of a tungsten/heavy metal alloy for tools such as extrusion dies and extrusion mandrels for the hot-forming of copper and copper alloys. The alloy consists of 80 to 89.9% by weight of tungsten, 2 to 7% by weight of chromium, remainder binder metal. The use of this alloy primarily results in a considerably reduced formation of grooves on the surface of the forming tools.

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USE OF A TUNGSTEN/HEAVY METAL ALLOY

The invention relates to the use of a tungsten/heavy metal alloy for tools for the hot-forming of copper and copper alloys.

During the hot-forming of metals and alloys in the solid state, which for materials which require frequent forming, such as steel and copper, generally takes place in a temperature range between 700°C and 1300°C, the corresponding forming tools are exposed to high thermal and mechanical loads. In particular, rapid temperature changes and chemical reactions or welding of the tool surfaces with the material to be formed impose high demands on the materials from which the forming tools are made.

It is known to use high-temperature resistant alloys, such as for example Inconel 718 or Stellite 21, to produce forming tools of this type. When the forming tools produced from these high-temperature resistant alloys are used, edge cracks, which lead to premature failure of the tool, are preferentially formed in particular during the extrusion of polygonal sections.

Furthermore, when these tools are used for prolonged periods at high temperatures, the dimensional stability decreases on account of a reduction in the hot strength of the alloys as a result of what are known as aging phenomena.

Furthermore, it is known to use tungsten/heavy metal alloys as materials for forming tools of this type.

The term tungsten/heavy metal alloys is used to refer to alloys which are based on tungsten and, in addition to a tungsten content of the order of magnitude of approximately 80 to 99% by

weight, also contain binder metals, such as iron, nickel, cobalt or copper. The addition of chromium to increase the hardness and to improve the resistance of heavy metal alloys to corrosion is also known.

The tungsten/heavy metal alloys are generally produced by powder metallurgy, involving compressing the starting powder and sintering with the binder metals in the liquid phase. Compared to pure tungsten, tungsten/heavy metal alloys are relatively ductile and easy to machine.

DE 27 27 892 C2 describes the use of a tungsten/heavy metal alloy comprising 90 to 97% by weight of tungsten and 2 to 10% by weight of iron and/or nickel, and also, if appropriate, up to 8% by weight of alloying elements, such as chromium, molybdenum or cobalt, for the production of tools for the hot-forming of metals in the solid state.

Metals which are mentioned as being suitable for forming using tools made from this alloy are in particular steel and copper. Tools mentioned include extrusion dies.

When these known tungsten/heavy metal alloys are used for forming tools, the tools are subject to a particularly high frictional stress in particular when forming copper and copper alloys. A chemical reaction with the copper material leads to grooves being formed on the surface of the forming tool, with the result that the surface quality of the formed workpieces is inadequate after only a relatively short time. To avoid this, it is necessary for the tool to undergo complex polishing work at regular, relatively short intervals.

Therefore, the object of the present invention is to provide an alloy for tools for the hot-forming of copper and copper alloys, the use of which leads to a considerably reduced formation of grooves on the tool surface and to a reduced formation of edge cracks during the forming of polygonal sections, and therefore to an improved service life of the tools.

According to the invention, this is achieved by using a tungsten/heavy metal alloy, consisting of 80 to 89.9% by weight of tungsten, 2 to 7% by weight of chromium, remainder binder metal.

The considerably reduced formation of grooves on the surface of forming tools when using the alloy according to the invention was altogether surprising, since the alloy according to the invention, which has a low tungsten content compared to the known tungsten/heavy metal alloys, does not have either a higher hot hardness or hot strength or an improved resistance to oxidation than these known tungsten/heavy metal alloys or than the high-temperature resistant alloys, for example Inconel 718, Stellite 21, which are used for forming tools according to the prior art.

As the person skilled in the art is aware, the resistance to oxidation of tungsten/heavy metal alloys is only improved by a chromium content of 10% by weight and above. However, even at chromium contents of over 7% by weight the alloy according to the invention is made considerably more brittle, so that it is no longer suitable for the production of forming tools.

Therefore, it is not possible to explain the effect which results in this reduced formation of grooves.

Forming tools made from the alloy according to the invention do not show any signs of a drop in their excellent resistance to

the formation of grooves even after prolonged usage at high temperatures, so that polishing work on the tools can be considerably reduced or even eliminated altogether. When forming polygonal sections, there are no edge cracks on the forming tools even after prolonged usage.

The tungsten/heavy metal alloy according to the invention is most expediently produced by powder metallurgy, involving compressing the starting powder mixture and sintering at a temperature at which the binder metals contained in the alloy are at least partially in the liquid phase. This leads to a virtually 100% density of the alloy.

The finished sintered alloy can if necessary be machined to the desired final shape of the forming tool without difficulty.

The binder in the tungsten/heavy metal alloy preferably consists of nickel and/or iron, although the binder metals nickel and iron may also be completely or partially replaced by other binder metals, such as Mo, Co, Cu, Al, Si, Hf, Ru, Pd and Rc.

The use of an alloy comprising 82 to 85% by weight of tungsten, 4 to 6% by weight of chromium and 9 to 14% by weight of nickel and/or iron has proven particularly advantageous.

If the alloy according to the invention is used to produce an extrusion die or an extrusion mandrel, the advantages of a reduction in the formation of surface grooves become particularly apparent. Furthermore, when extruding polygonal sections, the tendency to form edge cracks is reduced compared to alloys which have previously been used, which indicates a relatively improved thermo-mechanical fatigue strength.

The invention is explained in more detail below with reference to examples.

Example 1

Extrusion dies for the extrusion of rectangular sections with a cross section of 41.5 x 12 mm² were produced from a tungsten/heavy metal alloy according to the invention containing 82% by weight of tungsten, 8% by weight of nickel, 4% by weight of iron and 6% by weight of chromium. To do this, the corresponding metal powders, with a mean grain size of 4 to 8 µm, were mixed and were compressed to form suitable blanks by means of die presses. Then, the blanks were sintered under hydrogen at approx. 1500°C for 2 hours, so as to form a liquid phase. The sintered blanks were then given the desired final dimensions by machining.

Example 2

For comparative tests, extrusion dies made from a tungsten/heavy metal alloy according to the prior art containing 92% by weight of tungsten, 4% by weight of nickel, 2% by weight of iron and 2% by weight of chromium were produced in the same way as in Example 1.

Example 3

Once again for comparative tests, extrusion dies having the same dimensions and extruded sections as in Example 1 were machined from a commercially available semi-finished product made from the high-temperature resistant alloy Inconel 718.

Comparative tests

To compare the individual extrusion dies with one another, the Vickers hardnesses of each alloy were measured at room

temperature, oxidation tests were carried out at 900°C for 5 hours in air, and extrusion tests using copper at a forming temperature of 875°C and a reduction in cross section of 1:150 were carried out.

In Examples 1 and 2, reworking was in each case carried out on the extrusion dies by polishing the extrusion die if the surface quality of the extrudate was insufficient on account of excessive formation of grooves. The end of the service life of the extrusion dies was reached when the dimensional deviations on the extrudate caused by the reworking were excessive.

In Example 3, the end of the service life resulted from edge cracks in the die, which first became visible after just 16 extrusion operations and became continuously more pronounced.

The results of the comparative tests are compiled in Table 1 below:

Table 1

Extrusion die	Hardness HV 10	Oxidation removal in mg/cm	Number of extrusion operations until reworking of the die required		Number of extrusion operations before the end of the service life of the die	
Example 1 according to the invention	309	80	70	243		
Prior Art Example 2	344	71	6	50		
Example 3	406	0.3	-	63		

Claims

1. The use of a tungsten/heavy metal alloy, consisting of 80 to 89.9% by weight of tungsten, 2 to 7% by weight of chromium, remainder binder metal, for tools for the hot-forming of copper and copper alloys.
2. The use of a tungsten/heavy metal alloy as claimed in claim 1, characterized in that the binder consists of nickel and/or iron.
3. The use of a tungsten/heavy metal alloy as claimed in claim 1 or 2, characterized in that the alloy consists of 82 to 85% by weight of tungsten, 4 to 6% by weight of chromium and 9 to 14% by weight of nickel and/or iron.
4. The use of a tungsten/heavy metal alloy as claimed in one of claims 1 to 3 for extrusion dies and extrusion mandrels.

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