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PROCESS AND SOLUTION FOR REMOVING TITANIUM AND REFRACTORY METALS AND THEIR ALLOYS FROM TOOLS

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8 Claims

ABSTRACT OF THE DISCLOSURE

Titanium and refractory metals and their alloys are removed from tools, usually made from steel or carbides, without deleterious effects on the tool by immersing the coated tool in an acidic solution including fluoride ions, water, a source of COOH radical, such as formic, oxalic, or tartaric acid, and a corrosion inhibitor, such as triethanolamine, potassium iodide, or sodium nitrite.

REFERENCE TO OTHER APPLICATIONS

This application is a continuation-in-part of our co-pending application Ser. No. 803,118, filed Feb. 27, 1969 now abandoned.

BACKGROUND OF THE INVENTION

One of the primary reasons titanium is difficult to machine is that it tends to fuse to and coat the tools used to machine it, thereby rendering their cutting edges ineffective. Furthermore, the effect is cumulative with the deposit of a thin coat compounding the coating tendency and leading to complete seizing and galling of that portion of the tool which engages the workpiece. Once coated, the tools are either discarded or the coated portion is mechanically cut off and a suitable cutting edge is ground onto the end of the remaining portion. In the case of drill bits, often as much as one inch must be removed to rid the bit of the titanium fused to it. The cost of tool bits for machining titanium is, accordingly, a significant factor in the cost of the machined product.

One of the principal objects of the present invention is to provide a novel process and composition for removing titanium, refractory metals, and their alloys from tools without affecting the surface or other physical characteristics of the tool. Another object is to provide a process and composition for removing titanium fused to tool bits made of steel or carbides without destroying portions of the bits. A further object is to provide a process of the type stated which consumes little time and does not require continued surveillance.

SUMMARY OF THE INVENTION

The present invention comprises a solution for removing refractory metals and titanium and their alloys from tools made from ferrous metals and carbides and a process employing said solution. The solution is acidic and includes a source of fluoride ions, preferably hydrofluoric acid; water; a source of the COOH radical, preferably formic, oxalic, or tartaric acid, or mixtures thereof; and a corrosion inhibitor, preferably triethanolamine, ethylene glycol, or potassium iodide, or mixtures thereof.

DETAILED DESCRIPTION

In practicing the present invention, titanium covered tools are immersed in a hydrofluoric acid solution containing constituents which prevent the acid from attacking the tools metal and otherwise adversely affecting its sur-

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face, as well as other constituents for accelerating the dissolution of the titanium by the acid. While hydrofluoric acid is a well known etchant for titanium and titanium alloys, it alone is not suitable for removing titanium from steel inasmuch as it also attacks the steel, leaving a pitted surface thereon. Moreover, hydrofluoric acid alone requires considerable time to remove the last traces of titanium which are in intimate contact with the steel and, in addition, leaves a heavy black deposit, often called smut, on the steel.

The foregoing disadvantages are eliminated and hydrofluoric acid is rendered suitable for removing titanium in intimate contact with steel by the addition of formic acid and triethanolamine to the hydrofluoric acid.

The composition contains a source of fluoride ions, preferably hydrofluoric acid. Other suitable sources include fluoride salts, such as sodium or potassium fluoride. The weight percent of fluoride calculated as hydrofluoric acid is at least about 1%. The weight percent of hydrofluoric acid may be increased up to about 10%, but extremely high concentrations may attack the tool, and the upper limit is dependent on the type of material from which the tool is made, the temperature of the reaction, and the nature of the other constituents of the solution, in addition to the concentration of the fluoride ions.

For removing titanium from tool steel, a concentration of hydrofluoric acid of 3.5% by weight (corresponding to 10% by volume of 70% hydrofluoric acid) is preferred and can be used safely without danger of pitting or otherwise disturbing the surface of the tool. This concentration is also satisfactory for other tool material.

The tool materials to which this invention is applicable include: carbon steels, alloy steels, stainless steels, tool steels and tool materials known as carbides. The term "carbides," as used here, covers iron carbides, chromium carbides, tungsten carbides, and any other types of carbides.

The source of the COOH radical preferably is formic acid, but oxalic acid and tartaric acid and a mixture thereof can be substituted in whole or in part for formic acid. Oxalic and tartaric acids are somewhat less effective than formic acid and other sources of COOH radical such as succinic, adipic, malonic, etc., can be used. Mono and dicarboxylic acids of 1-6 carbon atoms are suitable for use in this invention.

The formic acid accelerates the dissolution of the titanium and, furthermore, effects removal of the last traces of titanium in intimate contact with the steel. To a limited extent, the formic acid also prevents the solution from attacking the steel. At least about 1% by weight formic acid is used in the composition. The preferred concentration is 2% formic acid by weight. The same weight percentages apply to oxalic and tartaric acids and other sources of COOH radical. Higher concentrations of formic acid can be used without any deleterious effects, but such higher concentrations produce no beneficial results and the excess is, therefore, merely superfluous. A practical upper limit of the COOH producing material is about 10% by weight (calculated as COOH radical).

A metallic corrosion inhibitor in the amount of at least about 1% by weight and preferably about 2% by weight is included in the composition. This ingredient suitably may be triethanolamine, sodium nitrite, or potassium iodide or mixtures thereof, or other suitable corrosion inhibitors. The preferred ingredient is triethanolamine.

The triethanolamine inhibits the hydrofluoric acid from attacking the steel and, in addition, prevents the formation of smut on the steel. Again, concentrations greater than 2% have no harmful effects nor does the excess produce any beneficial results. At least about 1% is neces-

sary. Again, a practical upper limit is about 10% by weight.

The temperature of the solution is not particularly critical with highly satisfactory results being obtained in the neighborhood of about 21° C. A practical temperature range is about 10° C. to about 33° C. Higher temperatures than indicated tend to produce some attack on steel and at lower temperatures the titanium removal rate becomes too slow to be practical.

Once immersed, the titanium covered steel should remain in the solution until all of the titanium has dissolved. Thus, the duration of the immersion is dependent on the amount of titanium in contact with the steel. For conventional twist drills having moderate amounts of titanium seized and galled on their working surfaces, an immersion of from 5 to 25 minutes in the solution is sufficient.

After the steel is removed from the solution, it is rinsed clean in dilute chromic solution (less than about 1% chromic acid). Dilute chromic acid solution is used to prevent rusting of the chemically cleaned tool. If the steel forms part of a cutting tool, the cutting edges thereon can be resharpened at this point, and the tool is then in condition for use again with only a nominal amount of metal having been removed during the sharpening operation.

While the foregoing solution readily dissolves the titanium including even that titanium in intimate contact with the steel, it does not pit or otherwise adversely affect the surface of the steel, nor does it alter the steel's mechanical properties.

SPECIFIC EXAMPLE

A solution having the following volumetric composition is suitable for rapidly removing titanium from steel without adversely affecting the steel:

	Percent
Hydrofluoric acid (70% concentration by weight) --	10
Formic acid -----	2
Triethanolamine -----	2
Water -----	86

The refractory metals include columbium, molybdenum, tungsten, and tantalum, and alloys thereof.

Thus, it is seen that this invention provides a process and composition for removing titanium and refractory metals and their alloys from a tool which achieves all of the objectives and advantages sought therefor.

This invention is intended to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure which do not constitute departures from the spirit and scope of the invention.

What is claimed is:

1. A composition for removing refractory metals and their alloys from a ferrous metal or carbide based tool without attacking the tool itself, said composition being acidic and consisting essentially of from about 1% to about 10% by weight of a source of fluoride ions calculated as hydrofluoric acid, from about 1% to about 10%

by weight of COOH radical provided by a COOH supplying material selected from the group consisting of mono and dicarboxylic acids of 1-6 carbon atoms, at least about 1% by weight of a metal corrosion inhibitor, and water.

2. The composition of claim 1 wherein the source of fluoride ions is hydrofluoric acid.

3. The composition of claim 1 wherein the corrosion inhibitor is selected from the group consisting of triethanolamine, sodium nitrite, potassium iodide and mixtures thereof.

4. The composition of claim 1 including hydrofluoric acid as a source of fluoride ions, wherein the source of COOH radical is selected from the group consisting of formic acid, oxalic acid and tartaric acid, and mixtures thereof, and the corrosion inhibitor is selected from the group consisting of triethanolamine, sodium nitrite, potassium iodide, and mixtures thereof.

5. A process according to claim 4 and further characterized by rinsing the tool with dilute chromic acid solution after it is removed from the composition.

6. A process for removing titanium, refractory metals, and their alloys from ferrous metal or carbide based tools, comprising the steps of: positioning a ferrous metal or carbide based tool having titanium, a refractory metal, or their alloys adhered to the working surface thereof into a solution containing from about 1% to about 10% by weight of a source of fluoride ions calculated as hydrofluoric acid, from about 1% to about 10% by weight of COOH radical provided by a COOH supplying material selected from the group consisting of mono and dicarboxylic acids of 1-6 carbon atoms, at least about 1% by weight of a metal corrosion inhibitor, and water; maintaining the tool in the solution until the adhered material has been removed by the composition; and removing the tool from the solution with the working surface of the tool unaffected by the solution.

7. The process of claim 6 wherein hydrofluoric acid is the source of fluoride ions, the source of COOH radical is selected from the group consisting of formic acid, oxalic acid, tartaric acid, and mixtures thereof, and the corrosion inhibitor is selected from the group consisting of triethanolamine, sodium nitrite, potassium iodide, and mixtures thereof.

8. The process of claim 6 wherein the temperatures of the solution is from about 10° C. to about 33° C. during removal of material from the tool.

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