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METHOD FOR TESTING COATINGS

Iral B. Johns, Santa Fe, N. Mex., and Amos S. Newton, Ames, Iowa, assignors to the United States of America as represented by the United States Atomic Energy Commission

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Our invention relates to a method for testing a coating on a base material for the presence of small pinholes, cracks, and other nonhomogeneities and discontinuities such as small uncoated portions of the coating not generally discernible on visual inspection.

In the past, various schemes have been devised for testing a coating on a base material, such as a metal base, for the presence of minute uncoated areas but such methods, while changing the appearance of the uncoated areas, have been found unsatisfactory for the purpose of our invention since minute pinholes and the like generally escape notice when under visual observation, or since the prior schemes are of limited application in other respects.

An object of our invention is to provide a method for testing a coating on a base that will reveal to the naked eye even minute pinholes and the like.

A more specific object of our invention is to provide a method of magnifying the pinholes in a coating of a base material and other minute uncoated areas of the base so that said pinholes and other uncoated areas will be readily discernible upon inspection.

Other objects and advantages will appear from a study of the following description.

It is often found desirable to coat a base, such as, for example, a metal or alloy base with a coating, such as, for example, a metal or alloy coating to protect the base from chemical reactions with the surroundings. As a specific example, when uranium metal is coated with a thin layer of aluminum, zinc, iron, nickel or other metal, or combinations thereof when direct coating is not possible, such layers are liable to have small cracks or holes which are not readily seen in inspection and that may have serious consequences in later use of the coated uranium. For instance, such coated uranium pieces may be used as fissionable elements in a combination with a moderator, such as, for example, a deuterium oxide (i. e. heavy water) moderator, in a nuclear chain reacting system. Any small uncoated areas of uranium would provide small openings through which highly radioactive fission fragments can emanate from the uranium when bombarded by neutrons slowed down by the moderator to thermal energies, that is, energies in thermal equilibrium with the surrounding atmosphere, such fragments contaminating the heavy water moderator, making it very radioactive. Deposition of such fragments will make apparatus, which it contacts, such as pumps, reservoirs and the like, also so radioactive as to require extensive shielding.

In accordance with our invention, a preferred method for testing such coatings for the presence of small pinholes and minute uncoated areas comprises exposing the coated uranium to an atmosphere of a reactive gas which is permanent or relatively non-condensable, such as, for example, hydrogen. In this preferred embodiment the hydrogen is heated to a temperature of approximately 200° to 300° C., to produce a rapid reaction with the material of the uncoated base. If a hole or crack is

present, for example, in an aluminum coating or uranium, a chemical reaction occurs between the exposed uranium and hydrogen to form a hydride of uranium, probably UH_3 or UH_4 or a combination of both such compounds. Since such hydride of uranium is a fine, light weight black or brownish black powder having about four times the volume of the original metal from which it is formed, the hole or crack is enlarged by pressure of the hydride, and the coating is lifted or cracked off making the flaw larger and easily visible to the human eye. The fact that the compound is of a color easily distinguishable from the coating aids in the visual detection of the presence of the flaw. Hydrogen is also especially desirable because of its ability to diffuse through even microscopic holes mainly because of its small molecular structure. Furthermore, hydrogen does not react with the coating.

Thus it will be seen we have provided an efficient method for making small pinholes and other small uncoated portions of a coated base readily observable to the human eye.

It will be understood that by "permanent" or relatively non-condensable gas is meant a gas which does not condense at ordinary room temperatures and under ordinary, e. g. atmospheric, conditions of pressure. It is at present preferred that there be no appreciable condensation of the treating gas to liquid on the surface of the coated object under test, and while this preferred result may be attained by appropriate control of temperatures or pressure, if necessary, the use of gas of relatively non-condensable character appears particularly advantageous, and in such event there is no need for any special control to prevent condensation, at any stage of the testing operation. As also indicated above, a feature of special importance is that the reaction between the gas and the base material (e. g. the reaction with the uranium, constituting either the whole, or as in an alloy, a part of the base material) is preferably such as to produce a relatively voluminous compound that exerts sufficient pressure on the coating to lift or break it away or otherwise to enlarge the hole or crack very appreciably.

While we have disclosed uranium as the base and hydrogen as the reacting gas, it should be noted that the invention is not restricted to the use of these specific elements and that other base metals, such as, for example, plutonium, thorium, zirconium, titanium, hafnium and the like rare metals, or alloys of these metals that react with hydrogen to form a hydride may be used and other gases than hydrogen, such as, for example, ammonia or other volatile hydrogenating agents may be used so long as they form a compound with the base (and not with the coating) that increases appreciably in size as compared to the size of the base portion entering the reaction.

Generally speaking, the gas is so chosen that the free energy change of the reaction between the gas and the base metal at the temperature employed is negative, and the product formed by the reaction of the gas with the base metal has a density lower than that of the base metal. The temperature selected is one at which the gas selected has no marked effect on the coating. We therefore do not wish to limit our invention except insofar as set forth in the following claims.

It is to be understood that unless otherwise stated, references in the claims to a base or a base material or to reaction or reactivity with such base or material, are generically intended to mean not only base materials consisting of a single element, such as uranium, but also base materials including a plurality of elements of which only one (or less than all) may actually enter into chemical reaction with the gas, e. g. as in testing a coating on a uranium metal base consisting of a uranium

alloy, where the flaw-detecting gas may not actually react with the supplemental constituents.

We claim:

1. The method of detecting minute uncoated areas of a metallic uranium base reactive to hydrogen and provided with a difficultly hydridable coating, comprising applying to the coated surface of the uranium base a heated atmosphere of gaseous hydrogen at a temperature at which uranium will react with hydrogen to form uranium hydride whereby enlargement of such areas if present will occur.

2. The method of detecting minute uncoated areas of a uranium metal base provided with a difficultly hydridable coating, comprising applying to the coated surface of the uranium metal base an atmosphere of hydrogen at a temperature of approximately 300° C. to form a hydride of uranium at such uncoated areas whereby enlargement of such areas if present will occur.

3. The method of detecting minute uncoated areas of metallic uranium provided with a difficultly hydridable coating, comprising exposing the coated surface of the metallic uranium to a hydrogenating gas reactive with the uranium metal at a temperature at which such gas will react with uranium to form uranium hydride whereby enlargement of such areas if present will occur.

4. A method of detecting defects in the coating of a coated article comprising an easily hydridable metal base and a difficultly hydridable jacket on the base which comprises exposing said coated article to an hydriding agent at a temperature sufficiently high to form the hydride of said base metal in any pores which may be present in the coating whereby to effect enlargement of such pores.

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