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Ignition of Binary Alloys of Uranium

Uranium is a metal important to the nuclear industries, yet it has many relatively poor properties as a metal. For example, it is active chemically, it is anisotropic, and it has undesirable mechanical properties. Also, impurities are often present in the uranium metal. The purpose of this investigation of uranium alloys is to improve upon the properties of the parent metal, uranium.

Seventy binary alloys, representing 24 different additives, were included in the study. Several of these additives were common impurities in uranium; others were selected because of their particular interest to the nuclear field. Most of the alloys were prepared in nominal concentrations of 0.5, 1, and 2 at%. All were analyzed for carbon, nitrogen, oxygen, hydrogen, and trace elements as well as for intentionally added constituents.

The experiments were performed by placing nominal 8.5-mm alloy cubes in a flowing oxidizing atmosphere within a furnace. The temperature of the furnace was then increased 10°C per minute. Differences in the sample temperature-time curves were noted for the various binary uranium alloys. Results were interpreted in terms of the effect of the alloying addition on the previously demonstrated transition of the oxide at 400°-500°C from an autocatalytic to a protective form.

Additions of aluminum and certain other alloys, including beryllium, bismuth, carbon, lead, molybdenum, niobium, palladium, platinum, ruthenium, silicon, titanium, and vanadium, inhibited the oxide transition and thereby lowered the ignition temperature. Another effect produced notably by copper, but also by bismuth, lead, palladium, platinum, ruthenium, and vanadium, was an increase in the protectiveness of the oxide formed at temperatures above 500°C. Very complex temperature-time curves were obtained when both effects occurred with the same alloy. Alloying additions of cerium, chromium, hydrogen, iron, nickel, rhodium, silver, tantalum, thorium, and zirconium had no significant effect on the ignition behavior of uranium at the low concentration levels studied.

Notes:

1. Related articles are: Baker, L. Jr., Schnizlein, J. G., and Bingle, J. D., "The Ignition of Uranium," *Journal of Nuclear Materials,* 20, p 22-38, 1966; Tetenbaum, M., Mishler, L., and Schnizlein, G., "Uranium Powder Ignition Studies," *Nuclear Science and Engineering,* 14, p 230-238, 1962; Baker, L. Jr., and Bingle, J. D., "The Kinetics of Oxidation of Uranium Between 300°and 625°C," *Journal of Nuclear Materials,* 20, p 11-21, 1966; Leibowitz, L., et al, "Burning Velocities of Uranium and Zirconium in Air," *Nuclear Science and Engineering,* 15, p 395-403, 1963; Mouradian, E. M., and Baker, L. Jr., "Burning Temperatures of Uranium and Zirconium in Air," *Nuclear Science and Engineering,* 15, p 388-394, 1963; and Leibowitz, L., Schnizlein, J. G., and Michler, L. W., "The Effect of Halogenated Hydrocarbons on the Burning of Uranium and Zirconium," *Nuclear Science and Engineering,* 15, p 404-410, 1963.
2. This information could be useful when applied to other metals, such as Al, Zr, Mg, B, Be, and Hf, used as fuels in pyrotechnics or in rocket engines.

(continued overleaf)

3. The effect of alloying additions on the ignition of uranium has been presented by J. G. Schnizlein, L. Baker, Jr., and J. D. Bingle of Argonne National Laboratory in "The Ignition of Binary Alloys of Uranium," *Journal of Nuclear Materials,* 20, p 39–47, 1966. The report, part of an extensive study on the ignition behavior of uranium, includes the experimental procedures and data on oxidation rates, ignition temperatures, and burning curves.
4. Inquiries concerning this innovation may be directed to:

Office of Industrial Cooperation
Argonne National Laboratory
9700 South Cass Avenue
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Reference: B68-10280

Source: J. G. Schnizlein,
L. Baker, Jr., and J. D. Bingle,
Chemical Engineering Division
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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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U.S. Atomic Energy Commission
Chicago Operations Office
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