Iridium-Doped Ruthenium Oxide Catalyst for Oxygen Evolution

Possible applications of this catalyst include fabrication of water electrolysis units in hydrogen generators.

NASA requires a durable and efficient catalyst for the electrolysis of water in a polymer-electrolyte-membrane (PEM) cell. Ruthenium oxide in a slightly reduced form is known to be a very efficient catalyst for the anodic oxidation of water to oxygen, but it degrades rapidly, reducing efficiency. To combat this tendency of ruthenium oxide to change oxidation states, it is combined with iridium, which has a tendency to stabilize ruthenium oxide at oxygen evolution potentials. The novel oxygen evolution catalyst was fabricated under flowing argon in order to allow the iridium to become doped with iridium.
Dispersion-strengthened molybdenum-rhenium alloys for vacuum plasma spraying (VPS) fabrication of high-temperature-resistant components are undergoing development. In comparison with otherwise equivalent non-dispersion-strengthened Mo-Re alloys, these alloys have improved high-temperature properties. Examples of VPS-fabricated high-temperature-resistant components for which these alloys are expected to be suitable include parts of aircraft and spacecraft engines, furnaces, and nuclear power plants; wear coatings; sputtering targets; x-ray targets; heat pipes in which liquid metals are used as working fluids; and heat exchangers in general. These alloys could also be useful as coating materials in some biomedical applications.

The alloys consist of 60 weight percent Mo with 40 weight percent Re made from (1) blends of elemental Mo and Re powders or (2) Re-coated Mo particles that have been subjected to a proprietary powder-alloying-and-spheroidization process. For most of the dispersion-strengthening experiments performed thus far in this development effort, 0.4 volume percent of transition-metal ceramic dispersoids were mixed into the feedstock powders. For one experiment, the proportion of dispersoid was 1 volume percent. In each case, the dispersoid consisted of either ZrN particles having sizes <45 µm, ZrO₂ particles having sizes <1 µm, or HfN particles having sizes of about 1 µm, HfO₂ particles having sizes <45 µm, or ZrO₂ particles at grain boundaries of the Mo-Re alloy. These materials were chosen for evaluation on the basis of previously published thermodynamic stability data. For comparison, Mo-Re feedstock powders without dispersoids were also prepared.

Tubular alloy specimens were fabricated by VPS onto rotating graphite mandrels as follows: In each case, the VPS chamber was evacuated, then the rotating graphite mandrel was preheated by the plasma spray gun. Once the desired preheat temperature was reached, one of the powders prepared as described above was made to flow to the gun, causing the alloy to be deposited on the mandrel. [A nearly iden-