Covering a Crucible With Metal Containing Channels

Metal is deposited on a sacrificial pattern that defines the channels.

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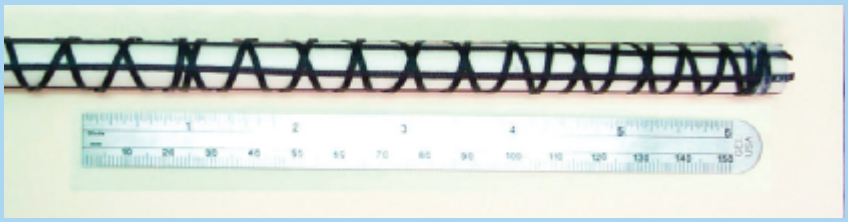
In a procedure that partly resembles the lost-wax casting process, a crucible made of a brittle material (ceramic, quartz, or glass) is covered with a layer of metal containing channels. The metal cover and the channels can serve any or all of several purposes, depending upon the application: Typically, the metal would serve at least partly to reinforce the crucible. The channels could be used as passages for narrow objects that could include thermocouples and heat-transfer strips. Alternatively or in addition, channels could be used as flow paths for liquid or gaseous coolants and could be positioned and oriented for position- or direction-selective cooling. In some cases, the channels could be filled with known gases and sealed so that failure of the crucibles could be indicated by instruments that detect the gases.

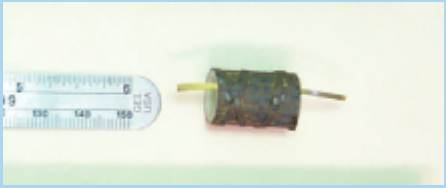
The process consists of three main steps. In the first step, a pattern defining the channels is formed by wrapping or depositing a material in the desired channel pattern on the outer surface of the crucible. The pattern material can be a plastic, wax, low-ash fibrous material, a soluble material, or other suitable material that can subsequently be removed easily. In a proof-of-concept demonstration (see figure), the crucible was an alumina cylinder and the mold material was plastic tie-down tape.

In the second step, the patterned crucible is coated with metal. In one variation of the second step, a very thin layer containing or consisting of an electrically conductive material (e.g., gold, silver, or carbon) is painted or otherwise deposited on the mold-covered crucible, then the covering metal required for the specific application is electrodeposited on the very thin conducting layer. In another variation of the second step, the metal coat is formed by chemical vapor deposition. In the proof-of-concept demonstration, a layer of nickel 0.003 in. (≈0.08 mm) thick was electrodeposited.



Plastic Tie-Down Tape Wrapped Around Alumina.

Wrapped Crucible After Plating With 0.003 Inch of Nickel.



Part of the Plated Crucible After Removal of the Tape With a Piece of Brass Sheet Threaded Through One of the Channels

Plastic Tie-Down Tape was wrapped around an alumina crucible, the tape-wrapped crucible was electroplated with nickel, then the tape was burned out, leaving nickel-walled passages covering the crucible.

In the third step, the patterned material is removed. This is generally done by heating the crucible assembly until the patterned material melts and runs out, vaporizes, and/or decomposes to an ash, leaving the channels. Alternatively, if the patterned material is soluble, it can be removed by use of a suitable solvent. In the proof-of-concept demonstration, the tape was burned away by heating the assembly to a temperature of 600 °C.

This work was done by Richard N. Grugel of **Marshall Space Flight Center**. *Further information is contained in a TSP (see page 1).*

This invention has been patented by NASA (U.S. Patent No. 6,802,999). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-31698-1.