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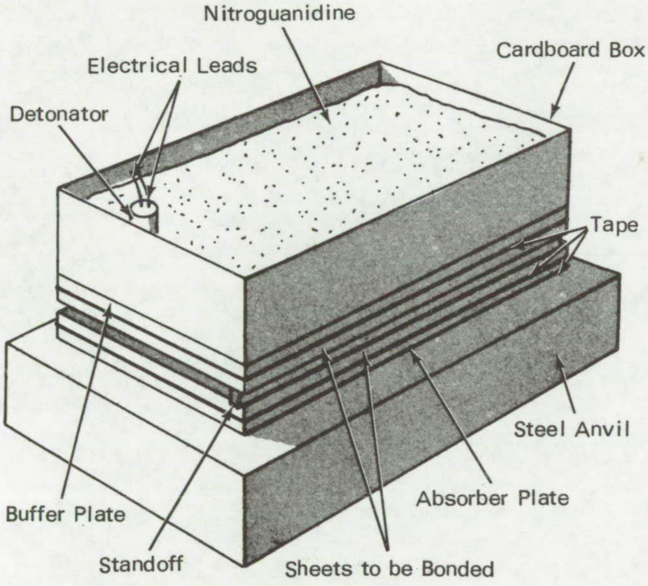
Explosive Bonded TZM-Wire-Reinforced C129Y Columbium Composites

A relatively new technique, for producing metal-filament reinforced metal-matrix composite sheets composed of refractory alloys, consists of positioning layers of TZM metal filaments between thin



Layup for Bonding

C129Y columbium sheets and subsequently joining multiple-sheet stacks by a single explosive joining operation. With the explosive joining technique, metallurgical bonds are excellent, external heat is not required, the process is relatively inexpensive, and the resulting composites are considerably stronger than the base alloy.

The developmental program consisted of three phases: Mechanical evaluation of TZM metal filaments and C129Y columbium sheet material; explosive bonding of TZM-filament reinforced C129Y sheet composites; and evaluation of explosive bonded composites.

The C129Y columbium sheet nominal chemical composition by weight was: tungsten 9-11%, hafnium 9-11%, tantalum 0.5%, yttrium 0.1-0.4%, zirconium 0.5%, and columbium balance. The TZM wire filament nominal chemical composition by weight was: titanium 0.5%, carbon 0.015%, zirconium 0.080%, and molybdenum balance.

Initial explosive bonding tests were conducted on C129Y columbium alloy sheet in order to establish essential explosive parameters, lay-up procedures, buffer materials and parting compounds. Nitroguanidine explosive was used because of its low detonation velocity, sensitivity, cleanness, and ease of establishing desired explosive densities.

The lay-up or stacking sequence (see fig.) consisted of an absorber sheet (with paper adhesive tape bonded to both surfaces) positioned on a steel anvil; the C129Y matrix sheets with appropriate parallel standoff, and the TZM filaments between the sheets, positioned above the absorber sheet; a buffer sheet (with paper adhesive bonded to the lower surface) positioned above the matrix sheets; and the nitroguanidine explosive in a cardboard container positioned above the buffer sheet. A blasting cap with a tetryl booster attached was positioned centrally in one end of the explosive container and, where wide sheets were utilized, a line wave generator was used to initiate the detonation front. The paper tape, used as a stop-off to prevent the buffer and absorber sheets from bonding to the composite, was positioned with the slick face to the composite.

Explosive bonding of the columbium sheets without TZM reinforcements increased the tensile strength

(continued overleaf)

7.2% and the yield strength 23.2%. The introduction of 14.7% of TZM filaments in the explosive bonded interface produced a yield strength increase of 50% and a tensile strength increase of 35.5%.

Note:

Requests for further information may be directed to:

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Reference: TSP71-10356

Patent status:

No patent action is contemplated by NASA.

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(MFS-20925)