Explosive Bonding of Metal-Matrix Composites

The problem:  
To make sheets of metallic composites, reinforced by unidirectional filaments of high-strength steel or by modular-filament sheets.

The solution:  
A novel process, using explosive bonding, produces sheet composites of 1100-0 aluminum alloy (tensile strength, 13,000 lb/in²) reinforced with wires of AM-335 stainless steel (tensile strength, between 400,000 and 500,000 lb/in²) having a tensile strength of 67,000 lb/in². The tensile strength of an explosive-bonded 2014-T6 aluminum composite, reinforced with a modular-filament sheet of custom 455 stainless steel, is 94,200 lb/in²; yield strength is 90,400 lb/in², elongation is 3.5%, and density is 0.120 lb/in³. The bonds are excellent metallurgically, no external heat is required, various metals can be bonded, and the process is inexpensive.

How it’s done:  
Typically an absorber sheet (0.125-in. aluminum of any temper), both surfaces covered with 0.008-in. adhesive paper, is positioned on a steel anvil. Over bonded 2014-T6 aluminum composite, reinforced with a modular-filament sheet of custom 455 stainless steel, is 94,200 lb/in²; yield strength is 90,400 lb/in², elongation is 3.5%, and density is 0.120 lb/in³. The bonds are excellent metallurgically, no external heat is required, various metals can be bonded, and the process is inexpensive. The absorber sheet is then covered with a sheet of metal, both covered with adhesive paper, and placed on a steel anvil. The assembly is placed in a quenching tank and a charge of black powder is placed on top of the absorber sheet. The charge is fired, and the anvil is dropped, causing the two sheets to bond together. The bonds are excellent metallurgically, no external heat is required, various metals can be bonded, and the process is inexpensive.

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it are placed the two matrix sheets having the reinforcing filaments rolled into them; between them are placed standoff spacers. A buffer sheet of 0.125-in. aluminum, its lower side coated with similar adhesive paper, is placed immediately over the matrices. Explosive nitroguanidine, in a cardboard container, covers the buffer sheet; centrally in one end of it is placed an E-90 blasting cap with a tetryl booster. Detonation is electrical.

To prevent longitudinal splits, the buffer sheet should be 3 in. greater in width than the matrices. Similar endwise overlap provides a velocity-stabilization ramp for the explosive and reduces transverse shears. Various problems and their corrective procedures are described, as well as many possible variations.

Notes:
1. The aircraft and shipbuilding industries and all fabricators of high-strength metallic composites may be interested.
2. Requests for further information may be directed to:
   Technical Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B69-10804

Patent status:
No patent action is contemplated by NASA.
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