Chapter 57

INTERFACIAL WAVE GENERATION IN EXPLOSIVE WELDING OF MULTILAMINATES

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Intensive work was carried out at UMIST on the fabrication of composites by one shot explosive bonding. Up to ten sheets of varying materials were arranged in parallel and the top was subjected to explosive detonation in the conventional explosive welding manner. Velocity measurements of each sheet, as well as metallographic examinations of the interface waves, were carried out.

The amplitude and length of the interface waves were found to depend much on the inertia of the impacted sheet and on the available kinetic energy in the impinging combination.

The paper discusses the implications of a simple theory developed to explain how the variation of the wavelength and amplitude, with distance away from the flyer plate, depends upon the inertia of the colliding plates.

I. INTRODUCTION

Commercial metal laminates are usually fabricated by a variety of processes, the most common of which are the roll bonding, brazing and explosive welding.

Generally, the literature on explosive welding reveals that attention was mainly focused on the two plates welding. Although few attempts were successfully carried out to compact multilayered wire and wire mesh reinforced composite cylinders (1-3) and panels (4-8) and bond multilayered cylinders (1-3 and 9) and panels (10-12), very little attention has been given to understanding the
peculiarities of these processes with particular reference to that of the multilayered cylinders and panels which branch from the two plate explosive welding process.

A typical setup for producing multilayered composites was reported by Wright and Levitt (13). In this setup the laminates were stacked on top of each other with appropriate gaps with the explosive positioned on a driver plate. Using this configuration, Wright and Bayce (10) were able to weld up to 100 alternate Al/Zn 0.55 mm thick layers in a single operation. A somehow similar technique was employed by El-Sobky and Blazynski (1-3 and 9) for the production of multilayered foil/foil and foil/wire mesh cylinders of various metal combinations. The explosive in this case was positioned around the outer surface of the cylindrical configuration.

The present work was undertaken with the intention of attempting to outline the salient features of the multilayered welding process. In order to identify the main parameters controlling this process and their effect on the quality of the product, special attention will be focused onto examining the production of multilayered panels of the same material. An understanding of this process will lead to a better understanding of the more general and practical case of dissimilar metals multilayered welding.

II. INTERFACIAL WAVES IN MULTILAYER WELDING

Experiments were undertaken to weld a number of flat layers of different material combinations using the parallel plate configuration of explosive welding. Typical data for some of the tests carried out are given in Table I which gives the materials welded as well as the various welding parameters used with each combination. Flyer and collision point velocities were measured using the pin contact method. The explosive used was various mixtures of Trimonite 1 and salt (14).

Microscopic examination of the interfaces of various composites revealed both wavy and plane interfaces. In wavy interfaces, it was generally found that the interfacial waves diminished in size as the interface position number increases (i.e. further away from the driver plate), while the condition of the waves at the last interface depends on how the last layer is supported. If no base plate is employed for supporting the last layer then further reduction in the size of the waves in comparison with those of the preceding interface will take place. Conversely, the use of a supporting base below the last layer results in an increase in the wave size in comparison with those formed at the preceding interface. This feature was repeatedly noticed in multilayer Aluminum composites.