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NASA TECH BRIEF

Electrical Resistance Determination of Actual Contact Area of Cold Welded Metal Joints

A method has been developed for measuring the area of the actual bonded zone of a compression weld by observing the electrical resistance of the weld zone while the load changes from full compression until the joint ruptures under tension. The adhesive bond efficiency, the ratio of bonding force to maximum tensile load, has been found to vary considerably, along with plastic strain. Measurable bonding forces required a minimum residual plastic strain factor of about 5×10^{-5}. The area actually bonded, as determined by metallurgical examination of welded surfaces, varied in proportion to the applied compressive load and to the plastic strain. For moderate deforming loads, the bonded area was substantially less than the total available contact area. However, under ideal conditions, in which contact surfaces were first abraded to remove adsorbed oxide films and then bonded under heavy compression, both at vacuum levels below 2×10^{-8} torr, joint strengths up to 45% of the maximum tensile strength for annealed materials have been produced.

For high-vacuum cold welding under compressive loads, a general description of the adhesion process has been obtained. However, the effects of many metallurgical strength factors, such as alloy composition, phase distribution, cold working, and grain size, have only partially been established. Accurate examination of these factors is limited by the difficulty in determining true bond strength. The force required to rupture a bond may be accurately determined by means of strain gauges, but precise measurement of the area of the bond has been impossible.

Several experiments were designed to solve this problem. Measurement of the electrical resistance of vacuum-formed junctions, when compared with metallurgical observations and strain measurements, enables the determination of the mean interface configuration of the contacting areas. It has been found that the junction contact resistance remains relatively constant with release of compressive load, decreases as the cube root of an applied tensile load in the elastic range, and becomes negligible for tensile loads in the plastic range.

Notes:

1. This innovation allows direct measurement of the actual bonded area of a compression joint under any loading condition. It may interest welding specialists, metallurgists, and materials testing technicians.
2. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference: NASA-CR-97678 (N69-11044), A Study of Adhesion and Cohesion of Metals

Patent status:

No patent action is contemplated by NASA.

Source: Dr. Monroe J. Hordon, of Norton Research Corporation under contract to NASA Headquarters (HQN-10472)

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