Aluminum soldering handbook

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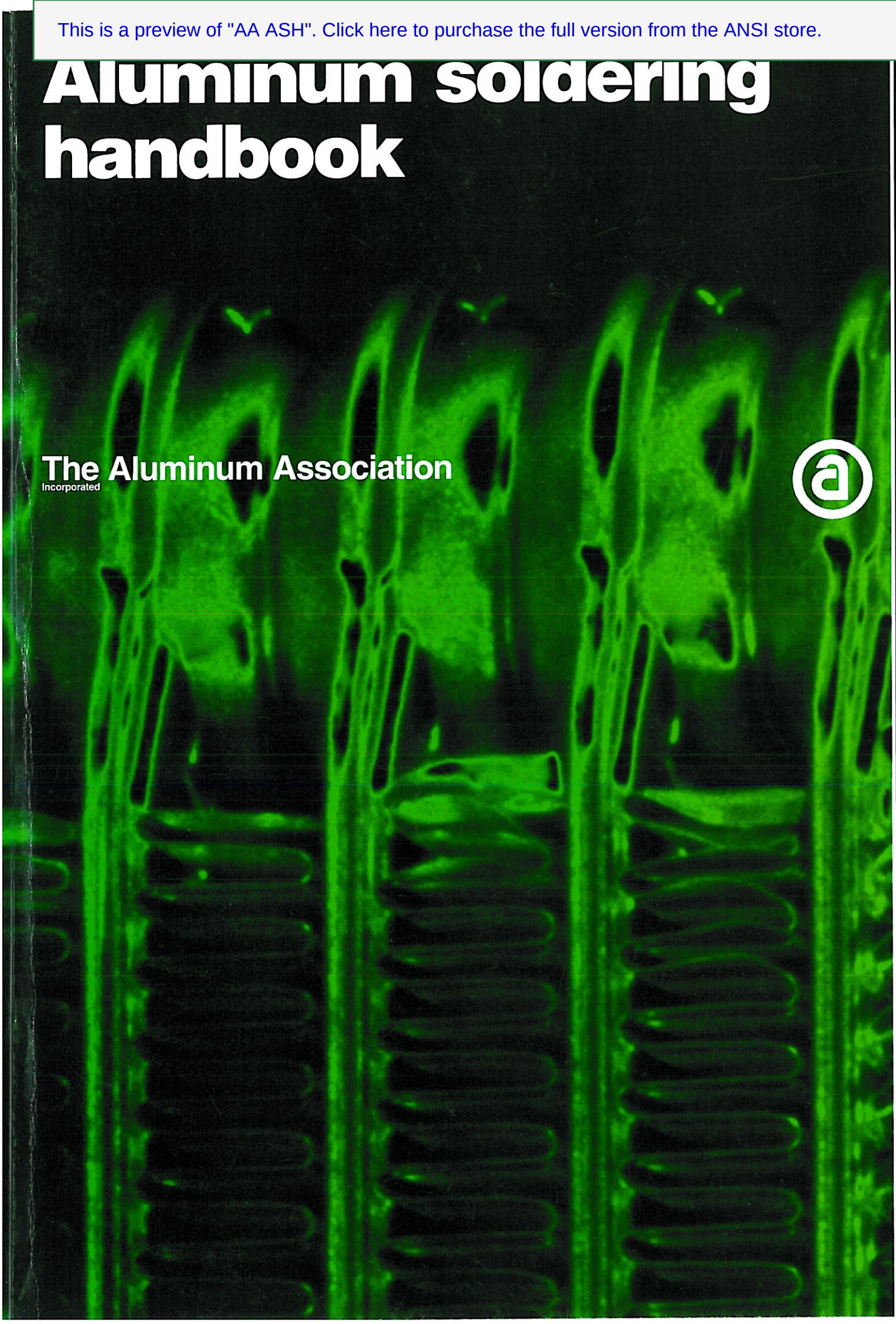

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About the Aluminum Association

The Aluminum Association, based in Washington, DC, with offices in Detroit, MI, represents U.S. and foreign-based primary producers of aluminum, aluminum recyclers and producers of fabricated products as well as suppliers to the industry. Member companies operate more than 200 plants in North America and many conduct business worldwide.

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ALUMINUM SOLDERING HANDBOOK

Fifth Edition
November 2004

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Foreword

The principles underlying soldering of aluminum are identical to those that make metallurgical bonding of other metals possible. After aluminum's tough protective oxide coating is removed, the soldering of aluminum proceeds along lines similar to those used with other metals, utilizing essentially the same techniques and equipment.

Properly made, aluminum joints are long lasting, gas tight and strong. Depending on the solder chosen, aluminum joints can be as strong as the metal joined. When tested, these joints fail at the base metal.

Aluminum is joined by soldering when many joints are to be made simultaneously and economically; when nearby material precludes the higher heats of brazing and welding; when component distortion must be avoided; when temper loss is to be held to a minimum; when equipment investment funds are limited; and when rapid field repairs with hand-held tools are needed.

Soldered aluminum joints are widely used in spacecraft, electronics, electrical power plants and power lines, household goods, refrigeration systems and air conditioning. The list of current and future solder applications is virtually endless.

Library of Congress Catalog Card Number 74-173196

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Chapter One

Introduction to Aluminum Soldering

Soldering is an inexpensive and rapid means of permanently joining aluminum to aluminum and to other metals. Properly made joints are leakproof and strong. Soldering is used for joining aluminum wires, making heat exchangers, spacecraft plumbing and thousands of other applications far too numerous to list here.

Aluminum soldering is relatively simple. Single joints are readily made in the field and shop with low-cost hand tools. Single and multiple joints, often numbering in the thousands, are automatically produced with comparatively low-cost equipment by semiskilled personnel.

Advantages of Soldering

By accepted American Welding Society definition, soldering is a joining process wherein coalescence between metal parts is produced by heating to suitable temperatures generally below 840°F, and by using a filler metal having a liquidus not exceeding 840°F (449°C) and below the solidus of the base metals. The solder is usually distributed between the properly fitted surfaces of the joint by capillary attraction. Brazing, by the same definition, is a similar process accomplished at temperatures above 840°F but below the melting point of the metals to be joined. Welding requires that the parent metals be brought to or above their melting points.

As soldering is accomplished at lower temperatures than brazing (and at considerably lower temperatures than welding), it is often possible, by proper selection of alloy and a low temperature solder, to solder aluminum with little loss of parent metal temper. Brazing requires a following quenching and aging treatment to restore temper. (This is only possible with heat-treatable alloys.) Remelting temperatures of soldered joints are too low to permit solution heat treatment of soldered assemblies in heat-treatable aluminum alloys.

In contrast to welding, the heat of soldering (and brazing) is fairly evenly distributed. Part expansion and subsequent contraction associated with soldering is far less an obstacle to precise joining than the inter-part motion generated by the intense, concentrated heat necessary for welding.

As soldering does not need to be followed by quenching (to restore temper) and as soldering is accomplished at lower temperatures than either brazing or welding, assembly distortion due to soldering is generally nil. By the same token, soldered assemblies have lower temperature-induced stresses as compared to brazed or welded aluminum assemblies.

The temperatures employed in soldering, the nature of the process and aluminum's excellent thermal conductivity combine to make it reasonably easy to solder complex assemblies with varied sections.

The fluxes normally used to solder aluminum are easier to remove than the fluxes normally used for brazing aluminum. There is also a group of aluminum soldering fluxes that, in many applications, do not need to be removed. (Certain organic fluxes are nonhygroscopic and noncorrosive.)

Aluminum may be soldered with a wide range of solders, a wide range of temperatures and a variety of fluxes. Brazing aluminum is accomplished in a narrow range of temperatures just below the melting point of the parent metal. Only a limited variety of fluxes are currently available for brazing. Soldering therefore offers the designer greater flexibility within its scope.

Aluminum is brazed at temperatures no more than about 50°F below the solidus temperature of the base metal, and frequently closer. Aluminum soldering temperatures are, at a minimum, 200°F below the solidus temperature of the base metal. Temperature control with aluminum soldering is therefore considerably less stringent and demanding than that necessary for brazing. Less skill is required on the part of the torch operator to keep from melting the base metal when soldering than when brazing. (The solidus temperature of a metal marks the onset of melting. Liquidus marks the thermal point at which the metal is completely liquid. Between its solidus and liquidus temperature points, a metal is semiliquid or slushy.)

Soldering aluminum is relatively simple. Written instructions are all that is needed for casual forming of joints. Commercial-quality soldering can be quickly taught.

Basic Process

Many techniques are currently used to solder aluminum.