Recent Metallurgical Developments for Tin

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Tin, one of the earliest metals used by man, continues to enter into a multitude of applications. New alloy developments, improvement of processes which use tin, and encouragement of basic research have opened new horizons in the applications for tin.

The advent of the Space Age has intensified the need for new, versatile metals and alloys. The use of tin and aluminium as alloying elements in titanium provides an alloy with good mechanical properties and higher creep resistance at elevated temperatures. The addition of 15 pct Sn increases the ultimate tensile strength of titanium by 90 pct at room temperature. Low-melting quaternary alloys of tin, indium, lead, and silver have been used for cryogenic circuits, and brazing filler alloys containing tin, nickel, chromium, and silicon are used to join assemblies which function at high temperatures. The

resulting joints are capable of resisting intergranular penetration or embrittlement after 400 hr at 1300°F. Techniques have been developed for bonding 20 pct Sn, 78 pct Al, and 2 pct Cu to steel bearing shells. Tin-aluminium bearing metals offer a combination of softness with high fatigue strength, which is amply maintained at temperatures reached by bearings in service.

Gold-tin alloys exhibit good oxidation and corrosion resistance, and have a high thermal heat conductivity; sintered tin bronzes, employed to filter various media, have proved to be strong and corrosion resistant. Tin, in amounts of about 0.1 pct, added to gray and nodular irons eliminates ferrite, resulting in a substantially pearlitic matrix. Additions of 3 to 7 pct Sn and 0.5 pct Al improve the hardenability of silver-copper alloys used in fabricating jewelry. Tin, alloyed with lead

and barium, has been used in battery grids, and semiconductor contacts have been enhanced by alloying tin with germanium or silicon.

Current demands, such as for lighter gage and wider tinplate have resulted in an increased use of tin. Continuous annealing and faster electrotinning speeds have favored the increased production of electrolytic tinplate in coils. It has been demonstrated that steels with the highest impurities react most rapidly with tin in forming the tin-iron intermediate compound during the flow-melting operation. The intermediate compound itself plays an important role in the internal corrosion resistance of tinplate cans.

Aluminium conductor cables are successfully welded by an exothermic reaction between powdered aluminum, tin oxide, and calcium fluoride flux. Ignition of the powder creates a molten tin alloy which flows into the joint, thus sealing the cable splice. Reliability of soldered joints is a primary concern of the missile and electronic industries. Evaluation programs indicate that hot-dipped or electroplated tin coatings 0.0003 in. thick are superior and least influenced by base metal, undercoat, or storage than other materials tested.

Fundamental research is underway to determine the true behavior of tin in steel. Since the solid solubility of tin in iron is high—approx 10 pct at 200°C—perhaps new alloy steels may be developed to meet the high strength requirements of industry.

This review does not attempt to do more than outline a few of the achievements of research and technical developments on the use of tin. It is hoped that the selection made here will show, to some extent, that the applicability of modern technologies and scientific research is not restricted to new materials, but extends equally to so ancient a metal as tin.

Below, vacuum arc furnace for melting Ti-Sn alloys.