A comprehensive survey of the welding methods in use today provides information on all types of welding methods and tools, including manual metal arc welding, gas shielded metal arc welding, tungsten inert gas shielded welding, plasma arc, and cutting.

The major focus of the current irradiation work is on understanding the fracture characteristics of irradiated high-copper weld materials and stainless steel cladding. Testing in the Fifth and Sixth HSST Irradiation Series are underway and include two high-copper weld materials (CU = 0.25 and 0.30%). Both crack initiation and arrest-toughness properties are being investigated. The tests also include Charpy V-notch, tensile, and compact specimens, with the latter ranging in size up to 4TCS for the irradiated high-copper weld materials. The Seventh Irradiation Series is examining the effects of neutron exposure on the fracture properties of stainless steel cladding.

Defect distributions in stainless steel and nickel-chromium alloy weld-deposited cladding over a low alloy steel base were characterized by destructive evaluation (DE). An evaluation of the observed defects was conducted to characterize the defects by type or classification. Size distributions of cladding defect types were developed from the information obtained. This paper presents the results of the cladding evaluation.

Effects of Irradiation on Initiation and Crack-arrest Toughness of Two High-copper Welds and on Stainless Steel Cladding

Defect distributions in stainless steel and nickel-chromium alloy weld-deposited cladding over a low alloy steel base were characterized by destructive evaluation (DE). An evaluation of the observed defects was conducted to characterize the defects by type or classification. Size distributions of cladding defect types were developed from the information obtained. This paper presents the results of the cladding evaluation.
Thermal aging of three-wire series-arc stainless steel weld overlay cladding at 288°C for 1605 h resulted in an appreciable decrease (16%) in the Charpy V-notch (CVN) upper-shelf energy (USE), but the effect on the 41-J transition temperature shift was very small (3°C). The combined effect following neutron irradiation at 288°C to a fluence of 5 x 10^{19} neutrons/cm^2 ( >1 MeV) was a 22% reduction in the USE and a 29°C shift in the 41-J transition temperature. The effect of thermal aging on tensile properties was very small. However, the combined effect of irradiation and aging was an increase in the yield strength (6 to 34% at test temperatures from 288 to 41°C). Neutron irradiation reduced the initiation fracture toughness (JIc) much more than did thermal aging alone. However, irradiation slightly decreased the tearing modulus but no reduction was caused by thermal aging alone. The effects of long-term thermal exposure times (20,000 and 50,000 h) will be investigated when the specimens become available.
Stainless steels represent a quite interesting material family, both from a scientific and commercial point of view, following to their excellent combination in terms of strength and ductility together with corrosion resistance. Thanks to such properties, stainless steels have been indispensable for the technological progress during the last century and their annual consumption increased faster than other materials. They find application in all these fields requiring good corrosion resistance together with ability to be worked into complex geometries. Despite to their diffusion as a consolidated materials, many research fields are active regarding the possibility to increase stainless steels mechanical properties and corrosion resistance by grain refinement or by alloying by interstitial elements. At the same time innovations are coming from the manufacturing process of such a family of materials, also including the possibility to manufacture them starting from metals powder for 3D printing. The Special Issue scope embraces interdisciplinary work covering physical metallurgy and processes, reporting about experimental and theoretical progress concerning microstructural evolution during processing, microstructure-properties relations, applications including automotive, energy and structural.

Defect Distributions in Weld-deposited Cladding

The most up-to-date coverage of welding metallurgy aspects and weldability issues associated with Ni-base alloys Welding Metallurgy and Weldability of Nickel-Base Alloys describes the fundamental metallurgical principles that control the microstructure and properties of welded Ni-base alloys. It serves as a practical how-to guide that enables engineers to select the proper alloys, filler metals, heat treatments, and welding conditions to ensure that failures are avoided during fabrication and service. Chapter coverage includes: Alloying additions, phase diagrams, and phase stability Solid-solution strengthened Ni-base alloys Precipitation strengthened Ni-base alloys Oxide dispersion strengthened alloys and nickel aluminides Repair welding of Ni-base alloys Dissimilar welding Weldability testing High-chromium alloys used in nuclear power applications With its excellent balance between the fundamentals and practical problem solving, the book serves as an ideal reference for scientists, engineers, and technicians, as well as a textbook for undergraduate and graduate courses in welding metallurgy.

Trends in Welding Research

An authoritative source of reference on every aspect of thermal welding and associated cutting processes. Each process is examined clearly and comprehensively from first principles through to more complex technical descriptions suited to those who need more technical information. Copiously illustrated throughout and with an extensive glossary of terms, this book is essential reading for welding and production engineers, metallurgists, designers, quality control engineers, distributors, students and all who are associated with the selection and application of equipment and consumables. (reprinted with corrections 2001)

Residual stresses and aging degradation of stainless steel weld overlay cladding for nuclear reactor pressure vessel (contract research)

This report describes in some detail the practical aspects of the explosive-bonding process, including basic mechanics of the process, practices of those in the field, metal combinations that have been bonded, and applications of explosively-bonded products. Methods of testing joints produced by explosive bonding are described. An exhaustive list of metal combinations which have been explosively-bonded is included in the report. (Author).

Projekt

Charpy Toughness and Tensile Properties of a Neutron Irradiated Stainless Steel Submerged-arc Weld Cladding Overlay

Welding Metallurgy of Stainless Steels

The possibility of stainless steel cladding increasing the resistance of an operating nuclear reactor pressure vessel to extension of surface flaws is highly dependent upon the irradiated properties of the cladding. Therefore, weld overlay cladding irradiated at temperatures and fluences relevant to power reactor operation was examined. The cladding was applied to a pressure vessel steel plate by the submerged-arc, single-wire, oscillating electrode method. Three layers of cladding were applied to provide a cladding thickness adequate for fabrication of test specimens. The first layer was type 309, and the upper two layers were type 308 stainless steel. There was considerable dilution of the type 309 in the first layer of cladding as a result of excessive melting of the base plate. Specimens for the irradiation study were taken from near the base plate/cladding interface and also from the upper layers of cladding. Charpy V-notch and tensile specimens were irradiated at 288°C to neutron fluences of 2 x 10²³ n/m² (E> 1 MeV). When irradiated, both types 308 and 309 cladding showed a 5 to 40% increase in yield strength accompanied by a slight increase in ductility in the temperature range from 25 to 288°C. All cladding exhibited ductile-to-brittle transition behavior during impact testing.
The ability of stainless steel cladding to increase the resistance of an operating nuclear reactor pressure vessel to extension of surface flaws depends greatly on the properties of the irradiated cladding. Therefore, weld overlay cladding irradiated at temperatures and fluences relevant to power reactor operation was examined. The cladding was applied to a pressure vessel steel plate by the submerged arc, single-wire, oscillating-electrode method. Three layers of cladding provided a thickness adequate for fabrication of test specimens. The first layer was type 309, and the upper two layers were type 308 stainless steel. The type 309 was diluted considerably by excessive melting of the base plate. Specimens were taken from near the base plate-cladding interface and also from the upper layers. Charpy V-notch and tensile specimens were irradiated at 288°C to a fluence of $2 \times 10^{23}$ neutrons/m$^2$ (>1 MeV). 10 refs., 16 figs., 4 tabs.

Stainless Steels

Stainless Steel Information Manual for the Savannah River Plant: Fabrication

Corrosion of Weldments

The objective of the study on the high-copper welds is to determine the effect of neutron irradiation on the shift and shape of the ASME $K_{Ic}$ and $K_{Ia}$ toughness curves. Two submerged-arc welds with copper contents of 0.23 and 0.31 wt % were commercially fabricated in 220-mm-thick plate. Compact specimens fabricated from these welds were irradiated at a nominal temperature of 288°C to fluences from $1.5 \times 10^{19}$ to $1.9 \times 10^{19}$ neutrons/cm$^2$ (>1 MeV). The fracture toughness test results show that the irradiation-induced shifts at 100 MPa/m were greater than the Charpy 41-J shifts by about 11 and 18°C. Mean curve fits indicate mixed results regarding curve shape changes, but curves constructed as lower boundaries to the data do indicate curves of lower slopes. A preliminary evaluation of the crack-arrest results shows that the neutron-irradiation induced crack-arrest toughness temperature shift is about the same as the Charpy V-notch impact temperature shift at the 41-J energy level. The shape of the lower bound curves (for the range of test temperatures covered), compared to those of the ASME $K_{Ia}$ curve did not appear to have been altered by the irradiation. Three-wire stainless steel weld overlay cladding was irradiated at 288°C to fluences of $2 \times 10^{19}$ and $5 \times 10^{19}$ neutrons/cm$^2$ (>1 MeV). Charpy 41-J temperature shifts of 13 and 28°C were observed, respectively. For the lower fluence only, 12.7-mm thick compact specimens showed decreases in both $J_{Ic}$ and the tearing modulus. Comparison of the fracture toughness results with typical plate and a low upper-shelf weld reveals that the irradiated stainless steel cladding possesses low ductile initiation fracture toughness comparable to the low upper-shelf weld. 8 refs., 12 figs., 2 tabs.
The high deposition pulse current GMAW process is a first-of-its-kind compilation. The nine chapters of this monograph may serve as a comprehensive knowledge tool to use advanced welding engineering in prospective applications. The contents of this book will prove useful to the shop floor welding engineer in handling this otherwise critical welding process with confidence. It will also serve to inspire researchers to think critically on more versatile applications of the unique nature of pulse current in GMAW process to develop cutting edge welding technology.

The use of tubular, or as it is often known, flux-cored wire has grown dramatically in the last thirty years. It is a versatile and productive weld material with wide applications. Yet this book is the first to provide fabricators with a comprehensive and unvarnished account of what tubular wires can do and how they do it. Based on the author's fifteen years' experience of developing and applying tubular wires, it brings together information not previously available in one place, some of which has never been published.

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