MECHANICAL ENGINEER

AN APPROACH FOR STUDYING THE CREEP/ SLIDING BEHAVIOR OF PLANAR METAL-SILICON INTERFACE

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There has been considerable recent interest in interfacial sliding during creep of multi-phase materials. The effect of interfacial creep is crucial for the deformation of metal-matrix composites and thin film systems, where the isostrain condition between the constituent components is often violated. An experimental approach has been developed to investigate the deformation kinetics of planar interfaces, using a double-shear specimen geometry where the interfaces are loaded in shear. In addition to shear stresses, the apparatus is capable of applying normal stresses (tension or compression) on the interface. In the experimental arrangement, the relative displacements of the constituents at the top and bottom of the specimen are measured independently with high precision using a resistance gauge and a capacitance sensor, respectively. The experimental set-up is suitable for both constant displacement-rate and constant-load creep tests, and can be operated up to a temperature of 500°C. In the current study, preliminary creep tests were conducted on planar aluminum-silicon interfaces prepared by diffusion bonding in argon atmosphere at 565°C. During the tests, the interfaces were subjected to nominally constant shear stresses ranging from 0.8-2 MPa, with the test temperatures ranging from 100-200°C. In all cases, the interface was found to slide via a time-dependent relaxation mechanism, indicating the suitability of the proposed test for studying interfacial sliding. Further studies are needed to determine the mechanistic details of interfacial sliding.

DoD KEY TECHNOLOGY AREA: Materials, Processes, and Structures

KEYWORDS: Composite, Planar Interface, Interfacial Sliding, Creep

FACTORS AFFECTING THE STRENGTH AND TOUGHNESS OF ULTRA-LOW CARBON STEEL WELD METAL

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The factors that affect strength and toughness of ten ultra-low carbon steel weld samples (HSLA-80 and HSLA-100), welded using the gas metal arc welding (GMAW) process and new ultra-low carbon consumable electrodes, were studied. The analysis was confined only to the weld metal, and the base metal was not considered. Analysis methods included optical microscopy, scanning electron microscopy, and transmission electron microscopy. Energy dispersive x-ray analysis was performed in the transmission electron microscope to analyze the chemical composition of non-metallic inclusions.

The microstructure was found to be primarily granular ferrite with some primary ferrite, bainite, and martensite. Very little acicular ferrite was found (< 18 %). Because of this, to get the best mechanical properties in the weld, the size and volume fraction of non-metallic inclusions needs to be minimized. This

can be accomplished by minimizing the amount of oxygen while increasing the amount of titanium and aluminum in the weld metal.

EDX analysis revealed that the non-metallic inclusions were multi-phase particles with two predominant phases: a TiO-MnO phase and a MnO-SiO_2-Al_2O_3 phase. Copper-sulfide caps were also found on the surface of some inclusions. This inclusion chemistry is typical of what is found in welding HSLA steel.

DoD KEY TECHNOLOGY AREAS: Materials, Processes, and Training, Surface/Under Surface Vehicles - Ships and Watercraft

KEYWORDS: HSLA-80, HSLA-100, Gas Metal Arc Welding, Ultra-Low Carbon Steel, Non-Metallic Inclusions