Accepted Manuscript

Microstructure, mechanical properties and strengthening mechanisms of friction stir welded Kanthal APMT™ steel

Anumat Sittiho, Vedavyas Tungala, Indrajit Charit, Rajiv S. Mishra

PII: S0022-3115(18)30417-3

DOI: 10.1016/j.jnucmat.2018.07.001

Reference: NUMA 51060

To appear in: *Journal of Nuclear Materials*

Received Date: 23 March 2018

Revised Date: 28 June 2018

Accepted Date: 2 July 2018

Please cite this article as: A. Sittiho, V. Tungala, I. Charit, R.S. Mishra, Microstructure, mechanical properties and strengthening mechanisms of friction stir welded Kanthal APMT™ steel, *Journal of Nuclear Materials* (2018), doi: 10.1016/j.jnucmat.2018.07.001.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Microstructure, Mechanical Properties and Strengthening Mechanisms of Friction Stir Welded Kanthal APMT™ Steel

Anumat Sittiho[a], Vedavyas Tungala[b], Indrajit Charit[a,1] and Rajiv S. Mishra[b]

[a] Chemical and Materials Engineering, University of Idaho, Moscow, ID 83844, USA

[b] Materials Science & Engineering, University of North Texas, Denton, TX 76203, USA

Abstract

Kanthal APMT™ steel (Fe-22Cr-5Al-3Mo) is being investigated for possible use as an accident-tolerant fuel cladding material in advanced light water reactors. Generally, high-chromium ferritic steels do not have good weldability because of a variety of metallurgical issues. In the present study, friction stir welding (FSW), a solid-state joining process, was applied to a Kanthal APMT™ plate in a bead-on-plate configuration using a tool rotation rate of 600 RPM and a traverse speed of 25.4 mm/min. Microstructure and mechanical properties were evaluated to determine the weld quality and examine feasibility of applying FSW as a joining technique for this steel. Microstructural characteristics were examined by optical microscopy and electron microscopy. The stir zone (SZ) contained equiaxed grain structure with an average grain size of 13.7 μm. Interestingly, Vickers microhardness profile across the processed zone revealed no significant change in microhardness. Mini-tensile testing, however, showed a marked improvement in mechanical properties of the SZ in the longitudinal direction compared to the base metal. The results are discussed in the light of fundamental strengthening mechanisms.

Keywords: Friction Stir Welding/Processing; Ferritic Steels; Kanthal APMT™; Accident-Tolerant Ferritic Steel

1. Introduction

Since the Fukushima-Daiichi nuclear disaster in 2011, efforts are ongoing to develop accident tolerant fuels and cladding materials for use in light water reactors. During the accident, water became steam due to high temperatures, which then reacted with zirconium based cladding alloys used in the boiling water reactors forming significant amount of hydrogen gas, ultimately leading to huge explosions among other outcomes. That is why there is a great interest in finding alternative cladding materials for light water reactors (LWRs), which can provide greater safety margins in the event of such accidents. One of the potential accident tolerant materials being considered for such applications is the aluminum-bearing ferritic steels [1-3].

[1] Corresponding author. I. Charit (e-mail: icharit@uidaho.edu; phone: +1-208-885-5964)

Download English Version:

https://daneshyari.com/en/article/7962942

Download Persian Version:

https://daneshyari.com/article/7962942

Daneshyari.com