Internal Letter

Rockwell International

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TO:

D. L. Roxby
SSD - Huntsville
D/114, 841-ZA14

FROM:

L. S. Burgess
SSD - Downey
D/284-202, 841-AB70
2-3006

Subject: Preliminary Evaluation of Laser Marked Mar-M-246 and Ti-6Al-4V

Ref. 1. RI-SSD M&P Lab Report No. PTN 027937
2. RI-Rocketdyne Report No. RSS-8735
3. RI-SSD M&P Lab Report No. PTN 027940

M&P is currently working with RI-Huntsville and Veritech, Inc. to evaluate Vericode marking on a variety of Orbiter materials. Candidate marking process methods include machine engraving, dot peening, microsand blasting and YAG laser marking. The purpose of this preliminary evaluation is to provide data for laser marking development and to determine what additional testing will be required. For this evaluation, Veritech supplied SSD-Downey with two laser marked Mar-M-246 cast nickel alloy turbine blades and one piece of Ti-6Al-4V sheet with nine different laser marks.

Actual laser marking parameters were unavailable for the Mar-M-246 turbine blades. Metallographic results showed (Ref. 1) that the recast layer was approximately 0.0005 inch deep with no cracking. Earlier testing performed at Rocketdyne (Ref. 2), showed that this condition will not significantly affect the tensile strength, ductility, low cycle fatigue or high cycle fatigue of cast Mar-M-246. Laser marking was found to be an acceptable method to mark turbine blades, if marked at the bottom of the fir tree.

A more detailed analysis was performed on the laser marked Ti-6Al-4V sheet because of concern regarding alpha case formation. The presence of alpha case or cracking at the surface may cause a reduction in material properties. The Ti-6Al-4V sheet sample was marked with a typical Vericode symbol in nine places. Each mark represented a different set of laser parameters including lamp current, beam speed and pulse frequency. According to Veritech, all marks were machine readable. The samples were visually examined using both SEM and optical microscopy. It was found that all marks had at least a minimal degree of alpha case. Vericode mark No. 9, which was produced using the "highest" laser parameters, had the greatest depth of alpha case with some cracking. From these data, it appeared that beam speed and lamp current had the greatest affect on alpha case formation.

M&P recommends that for each of these alloys, parameters should be optimized so that the least amount of heat is generated during processing. The effect of laser marking on cast Mar-M-246 has been studied at SSD-Rocketdyne and was found to have a negligible effect on material properties. Additional tests will be necessary, however, for laser marked Ti-6Al-4V. The presence of alpha case is expected to have an effect on material properties, therefore, tension and fatigue testing will be required.

L. S. Burgess

L. S. Burgess, Engineering Specialist
Metals & Metals Processing
Materials & Processes Engineering, L&T

cc: T. A. Bejarano
R. M. Ehret
W. E. Essig AE24
G. C. Frey
M. T. Liefeste
J. R. Liston FA83
C. E. Silverman
B. E. Syms
C. S. Thatcher
L. B. Thompson AC69