ID 37: MICROSTRUCTURAL EVALUATION OF MARAGING 300 STEEL LASER TREATED

Adriano Gonçalves dos Reis[1,2]*, Danieli Aparecida Pereira Reis[3,4], Antônio Jorge Abdalla[4,5], Antônio Augusto Couto[2,6], Luciana Aparecida Narciso da Silva Briguente[3], Luiz Ricardo Olivetti Marchetto[3], Javier Oñoro Lopez[7]

[1]Universidade Estadual Paulista (Unesp), Instituto de Ciência e Tecnologia, São José dos Campos.
[2]Instituto de Pesquisas Energéticas e Nucleares (IPEN), Ciência e Tecnologia de Materiais, São Paulo.
[3]Universidade Federal de São Paulo (UNIFESP), Instituto de Ciência e Tecnologia, São José dos Campos.
[4]Instituto Tecnológico de Aeronáutica (ITA), Materiais e Processos de Fabricação, São José dos Campos.
[5]Instituto de Estudos Avançados (IEAv), Fotônica, São José dos Campos.
[6]Universidade Presbiteriana Mackenzie (UPM), Engenharia de Materiais, São Paulo.
[7]Universidade Politécnica de Madrid (UPM), Engenharia e Ciência de Materiais, Madrid.

1. Introduction

Maraging steels are Ni-Co-Mo-Ti alloys of ultra-high resistance and spread application, since defense and nuclear industry until aeronautic components, pressure vessels and sports industry. Maraging steels have been investigated by a number of steel producers, mainly for nuclear and aerospace applications, due to high mechanical resistance allied to an excellent tenacity, behavior that are required to reduce weight and increase safety [1]. These steels are part of the priority list of advanced materials to the Brazil's technological development and are proposed to replace the current 300M in some parts of Brazilian satellite launcher [2,3]. Maraging steels are composed by a metastable martensitic microstructure. Some research show that they revert to austenite when heated at intermediate temperatures, close to the aging temperature, becoming worst when increasing temperature and time of exposure [1]. This work aims to evaluate the microstructural behavior of a maraging 300 steel after superficial laser treatment to reduce the oxygen permeability in the structure, increasing the mechanical resistance at elevated temperatures. Microstructural characterization will be done by scanning electron microscopy (SEM), X-ray diffraction and roughness by profilometry.

2. Experimental

The maraging steel used in this study was a 300-grade solution treated at 820 °C— 1 h in a Brasimet Koe 40/25/65 furnace. Samples of 20 x 20 mm and 3 mm in thickness was grinded by using 200# and 600# SiC paper and then cleaned with acetone in a ultrasonic bath for 20 min. Laser surface treatment was carried out using a Rofin DY 033 Nd:YAG continuous laser, which was operated at a wavelength of 1064nm. The focus laser spot size had a diameter of 0.5 mm, and the treatment was performed under a nitrogen flow rate of 20 l/min. The energy and the sample speed were set at 675 W and 100 mm/s, respectively. The focal length of the lens used equaled 120 mm. Following laser surface treatment, the surface was characterized by scanning electron microscopy (SEM), X-ray diffraction and profilometry.

3. Results and Discussions

Fig. 1 is a SEM micrograph showing the surface of the laser treated maraging 300 steel. We clearly see the laser path, each track typically 500 µm wide.

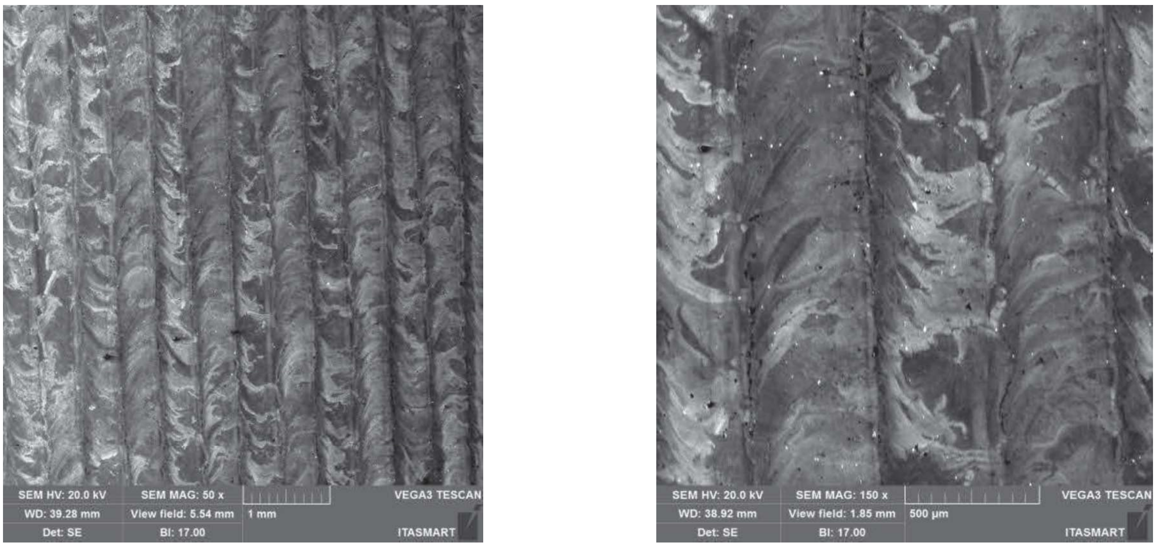

Fig. 1. *Micrograph maraging 300 steel surface treated with magnification of (a) 50x and (b) 150x.*

*Corresponding author: adriano.reis@ict.unesp.br

Fig. 2 is the 2D and 3D profilometry of the laser treated material. Surface roughness results: $R_a = 634 \pm 160$ nm; $R_q = 789 \pm 185$ nm and $R_t = 8{,}2 \pm 3{,}2$ nm.

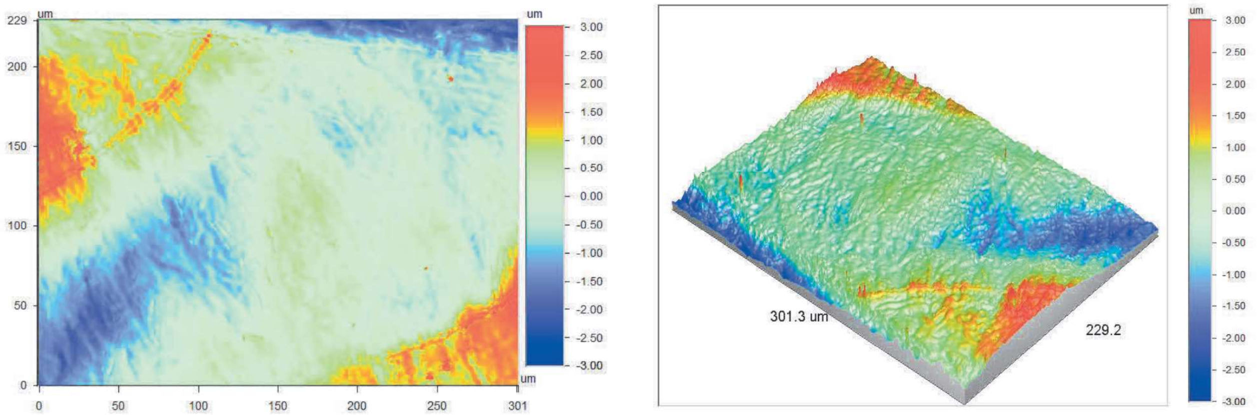

Fig. 2. *2D (a) and 3D (b) optical profilometry images of maraging 300 steel laser treated.*

The XRD pattern in the 2θ ranging from 30–100º of maraging 300 steel with and without laser treatment are shown in Figure 3. Both samples exhibit diffraction peaks due to the martensitic phase α'-Fe, but laser treated sample exhibit additional diffraction peaks related to austenite phase (γ-Fe) at 50.7° and related to Fe_2N/Fe_3N at 40.2°. Austenite phase formation can be associated to the overaging caused by laser heating [1,4], and the iron nitrides are probably associated to the nitrogen gas added during the laser treatment.

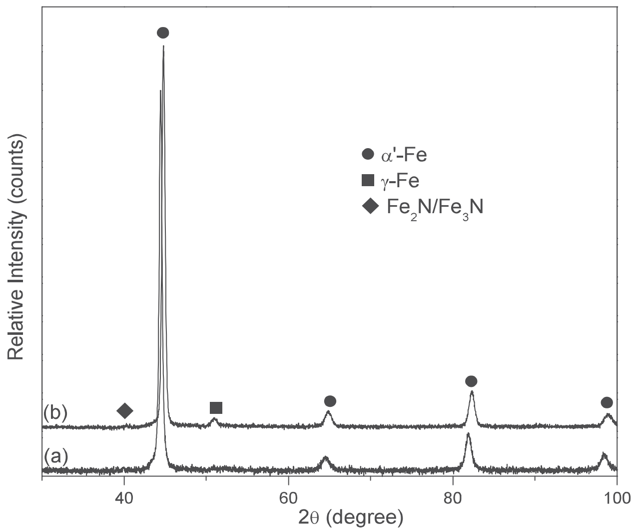

Fig. 3. *X-ray diffraction pattern of maraging 300 steel (a) without laser treatment and (b) laser treated.*

Creep tests will be performed to evaluate the effect of microstructural change by laser treatment in the mechanical resistance at elevated temperatures.

4. References

[1] W. Sha and Z. Guo, "*Maraging steels: modelling of microstructure, properties and applications*", Woodhead Publishing, USA, (2009).

[2] F. C. R. Assunção, "*Materiais avançados: 2010-2022*". Centro de Gestão e Estudos Estratégicos, Brasília, (2010).

[3] D. R. Santos, *Otimização dos parâmetros de tratamento térmico e soldagem do aço maraging 18Ni 300*. 2001. 118 f. Dissertação (Mestrado em Engenharia Mecânica) - Universidade Estadual Paulista Julio de Mesquita Filho, Faculdade de Engenharia de Guaratinguetá.

[4] A. G. Reis, D. A. P. Reis, A. J. Abdalla, J. Otubo, Mater. Charact., **107**, 350-357, (2015).

Acknowledgments

This work was supported by CNPq (Proc.nº 403070/2016-3) and FAPESP.

*Corresponding author: adriano.reis@ict.unesp.br