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ON THE INTERFACE BETWEEN SURFACE-MELTED AND SOLID STATE TRANSFORMED LAYERS IN LASER PROCESSED IRON ALLOYS

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Abstract: Surface melting of iron alloys by power laser treatments can lead to the formation of detrimental layers mainly constituted by austenite in the upper part of the solid state transformed regions. The formation of these layers was investigated and related to the thermal gradients and carbon diffusion from the melt.

1. Introduction

In the technologically important sector of iron alloys, laser surface melting sometimes leads to the formation of thin layers mainly constituted by austenite in the upper part of the solid state transformed regions. The presence of these relatively soft (HV $\cong$ 3.5 kN/mm^2) 'white layers' may have a significant influence on the mechanical properties of the treated materials.

2. Experimental

Plates of the steels AISI 1040, 9840 and 52100 were graphite or phosphate-coated and submitted to single-pass laser treatments in air or in helium stream. The laser processing conditions ranged from 1.5 to 11.6 kW/cm^2 incident power density and 0.13 to 2 s interaction time.

The phase composition of the laser transformed regions was determined by X-ray diffraction analysis using CoKα radiation, and by surface Mössbauer measurements, by detecting the 6.4 keV X-rays and the K shell conversion electrons re-emitted by the Fe atoms.

Metallographic observations and microhardness measurements were carried out on cross sections of the treated samples.

3. Results

The formation of mainly austenitic soft layers in the upper part of the solid state transformed regions involves:

1) Carbon enrichment of the melt, e.g. from the anti-reflection coating. The carbon concentration can be attenuated by decarburizing phenomena ensuing from oxidizing melt-environment interactions.
2) Diffusion of carbon from the melt in the underlying region austenitized during the heating stage of the laser treatment.
3) High thermal gradients in the austenitized solid, which allow carbon to concentrate within narrow regions where austenite can be stabilized.

   With low thermal gradients carbon diffuses in depth giving rise to a gradually decreasing profile of retained austenite.

The formation of these austenitic layers can be avoided by properly selecting the compositions of base alloys, the anti-reflection coating, and the laser processing conditions.