RUBY LASER DAMAGES ON WIRON S ALLOYS

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The new, multicomponent Ni alloy has been investigated regarding its interaction with impuls lasers, since the mechanisms of such interactions are not well understood so far. Damages obtained by ruby laser in the Q switch regime are investigated by scanning electro microscopy (SEM). The experimental results provided a relationshipbetween parameters such as cavity depth and diameter with an energy input.

INTRODUCTION

Interaction mechanisms of impuls lasers with materials, including welding, brazing and small hole drilling, have increasing practical importance. Wide range of stimulated light interaction with materials was related mainly to the reflection and transparency coefficients for a given wave length, heat capacity and conductivity, and temperature conductivity, (1,2). Anyhow, althought examination of physical quantities provides certain facts toward an explanation of laser beam interaction with investigated material, there are still quite different conclusions about it, (3). Therefore, the aim of this paper is to investigate the intensity, shape and character of material interaction with a ruby laser of given impuls shape, applying different energies, power densities and action periods. In order to perform such an investigation, microstructural examinations were used.

THEORETICAL BASIS

According to the literature, (4), crack length in the failed material can be determined as follows:

$$\sigma_e = [\beta E_y \Delta T' / 3(1-2E_p)] r(t)^2/\rho^2 \quad (1)$$

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$$L = \{[\beta E_y \Delta T'/3(1-2E_p)]r(t)^2/\rho^2\}^{1/2} \quad (2)$$

where β denotes volume thermal coefficient, E_y Young's modulus of elasticity, $\Delta T'$ temperature changes in front of melting area, r(t) - cavity radius, E_p Poisson's ratio and ρ mass density.

In order to determine these parameters, additional investions are necessary, based on specific quantities (3)

$$\rho'_c = 0.885\ T_M\ a\ \tau \quad (3)$$

$$\rho''_c = 0.885\ T_V\ a\ \tau \quad (4)$$

$$a = \lambda/\rho c \quad (5)$$

where ρ' and ρ'' denote critical laser radiation power intensities for material melting and evaporating, respectively, τ laser pulse duration, a temperature conductivity and c heat capacity.

RESULTS AND DISCUSSION

Microstructure examinations, as well as damage identification, were performed using SEM and electron microscopy. Figure 1 shows the appearance of a basic material structure (magnification 203x), indicating typical cast structure of eutectic type (Ni-Cr). Figures 2 and 3 show damages in materialobtained by laser drilling, using the parameters given in Table 1. As it can be seen, for the same laser pulse duration, damage is more or less proportional to the beam energy.

Table 1 Conditions of WIRON S samples treatment by ruby laser

damages number	E (J)	pulse duration (ns)	wave length (nm)
1	0.75	30	694.3
2	1.8	30	694.3
3	4.7	30	694.3

Figure 2 shows general appearance of a damage, being irregulary shaped. The secundary phases presence is obvious. It would be interesting to identify its presence also by difractional electro analysis. The outer damage diameter is 0.142 mm, while the inner diameter, characterizing damage center area (being in depth), is approximately 0.053 mm. Edges of damage are uneven.

Figure 3 shows an edge of a damage, indicating large number of micro pores, with diameter approximately 0.045 mm.

Samples shown in Fig. 2 and 3 were obtained using energies of 0.75 J and 1.8 J, respectively. The outer diameter of damage (0.498 mm) in Fig. 3 is much larger than the one in Fig. 2, as well as the inner diameter of a central damage area, being 0.136 mm.

CONCLUSIONS

On the basis of the experimental results presented in this paper one can conclude the following:

- Damage (cavities) in WIRON S alloy, caused by ruby laser, depend, both in depth and diameter, on the energy input.
- Large laser energy inputs cause cracking in material
- More detailed investigation of a structure are recommended, in order to determine the influence of secondary phases, typical for the eutecticum alloy, on a cracking in material.
- Having in mind large laser energy inputs, causing non-linear material characteristics, some additional numerical calculations are necessary.

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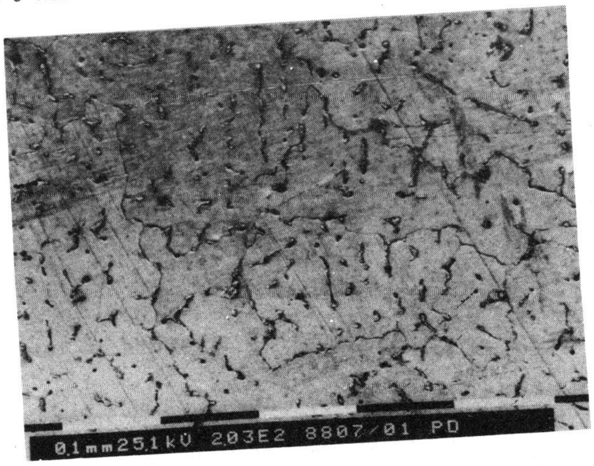

Figure 1 Appearance of a basic material structure (203x)

Figure 2 Damage 1 (Table 1) magnification 549x

Figure 3 Damage 2 (Table 1) magnification 263x