# STRENGTHENING THE AREA AROUND HOLES DRILLED IN NIMONIC 263 SHEETS USING THE LASER BEAM

Sanja Petronic[1], Zoran Stevic[2], Silvana Dimitrijevic[3]

[1]Innovation Center, Faculty of Mechanical Engineering in Belgrade;
[2]University of Belgrade, School of Electrical Engineering, Technical Faculty in Bor;
Central Institute for Conservation, Belgrade;
[3]Mining and Metallurgy Institute, Bor
Serbia

zstevic@live.com

*Nimonic 263 alloy is used for the parts of machines which operate at elevated temperature and pressure due its ordinary mechanical properties, oxidation and corrosion resistance. However, drilling holes in the Nimonic 263 sheet leads to the material weakening. In this experiment, the area around the hole and inner area of the hole are exposed to laser beam action, which strengthens these areas.*

*Keywords: laser, superalloy, scanning electron microscope (SEM), energy dispersive spectrometry (EDS), optical microscope.*

Lasers are used for precision machining of materials due to the specific nature of laser light, high intensity and the ability to control surface modifications. The technology of reinforcement of new materials by laser treatment was experimentally performed on nickel alloy Nimonic 263.

The experimental setup is presented in Fig. 1, and the chemical composition of Nimonic 263 is listed in the Table. Dimensions of Nimonic 263 sheets are 2×10×120 mm, and a radius of the hole drilled in the middle of the sheet is 4 mm. The area around the hole presents the weakest place on the sheet. These areas around the holes are laser machined to strengthen the material around the drilled holes, in terms of reinforcing the location where the stress concentration is expected.

In this experiment, nanosecond Nd:YAG laser Thunder Art manufactured by Quanta System is used, and laser parameters are: wavelength — 1064 nm, pulse duration — 8 ns, frequency — 20 Hz, laser energy — 0.9 J, and time of exposition — 5s.

Observed areas are investigated by optical microscope, scanning electron microscope, spectrophotometry and energy dispersive spectrometry.

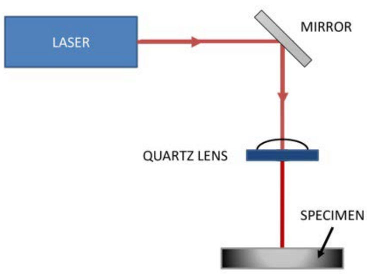


Fig. 1. Experimental setup

Chemical composition of Nimonic 263 alloy in wt%

| Elemnt | C | Si | Mn | Al | Co | Cr | Cu | Fe | Mo | Ti | Ni |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 0.06 | 0.3 | 0.5 | 0.5 | 20 | 20 | 0.1 | 0.5 | 5.9 | 2.2 | ball |

Fig. 2 presents an image of the area around the hole before and after laser treatment, while Fig. 3 shows the inner side of the holes before and after laser treatment. All images are taken by optical microscope.

Fig. 4 presents the surface of the Nimonic 263 sheet before and after the laser irradiation taken by scanning electron microscope. It can be noticed that the surface is cleaner, without the cracks after the laser beam action.

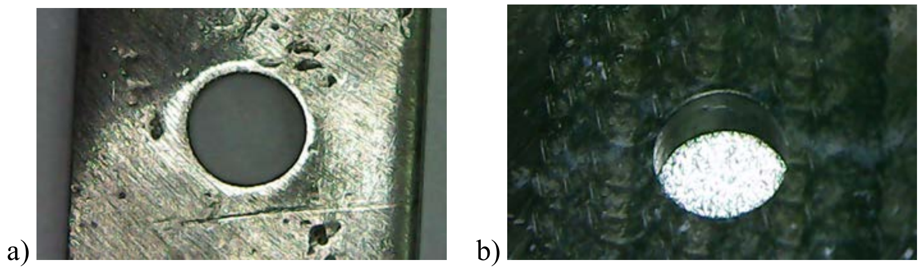


Fig. 2. Image of a Nimonic 263 sheet with a drilled hole before (*a*) and after (*b*) laser treatment taken by optical microscope

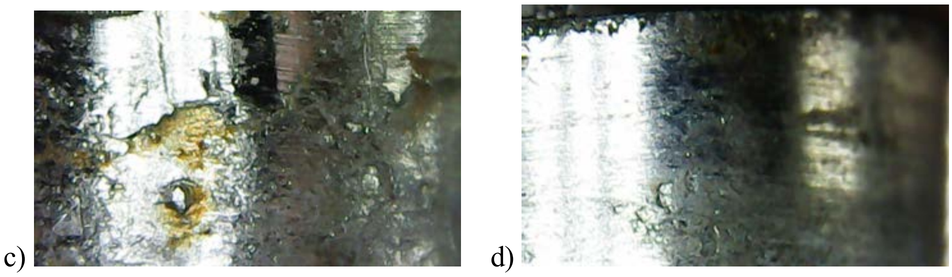


Fig. 3. Image of the inner side of the drilled hole in the Nimonic 263 sheet before (*a*) and after (*b*) laser treatment taken by optical microscope

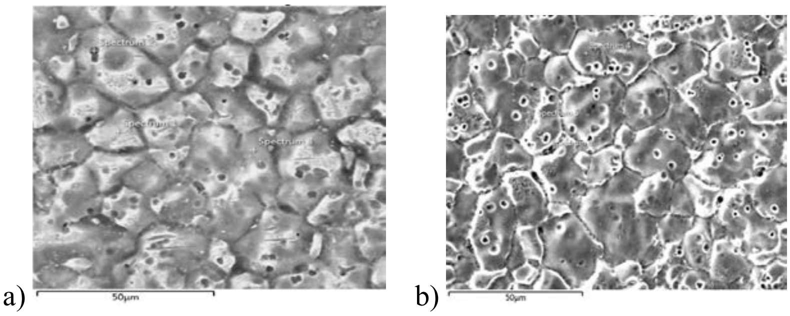


Fig. 4. Image of the Nimonic 263 sheet with a drilled hole before (*a*) and after (*b*) laser treatment taken by scanning electron microscope

REFERENCES

1. Li Y, Zhou L, He W. et al. The strengthening mechanism of a nickel-based alloy after laser shock processing at high temperatures // Sci Technol Adv Mater.— 2013.— Vol. 14(5).— 055010.— https://doi.org/10.1088/1468-6996/14/5/055010

2. Tadavani S.A., Razavi R.S., Vafaei R. Pulsed laser-assisted machining of Inconel 718 superalloy // Opt Laser Technol.— 2017.— Vol. 87.— P. 72—78. https://doi.org/0.1016/j.optlastec.2016.07.020.

3. Semaltianos N.G., Perrie W., French P., Sharp M., Dearden G., Logothetidis S., Watkins K.G. Femtosecond laser ablation characteristics of nickel-based superalloy C263 // Appl. Phys. A.— 2009.— Vol. 94.— P. 999—1009.

4. Petronic S., Sibalija T., Burzic M. et. al. Picosecond laser shock peening of Nimonic 263 at 1064 nm and 532 nm wavelength // Metals.— Vol. 6(3).— P. 41.— https://doi.org/10.3390/met6030041

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С. Петроніч, З. Стевіч, С. Дмитрович

**Зміцнення області навколо отворів, просвердлених в листах Nimonic 263 з використанням лазерного променя**

*Сплав Nimonic 263 використовується для деталей машин, які працюють за підвищеної температури та тиску завдяки своїм стандартним механічним властивостям, стійкості до окислення та корозії. Однак свердління отворів в листі Nimonic 263 призводить до ослаблення матеріалу. В цій роботі область навколо отвору і внутрішня область отворів піддаються впливу лазерного променя, і таким чином ці області зміцнюються.*

*Ключові слова: лазер, суперсплав, скануючий електронний мікроскоп (СЕМ), енергетично-дисперсійна спектрометрія (ЕЦП), оптичний мікроскоп.*