

# THE APPLICATION OF LASER CLEANING IN PAPER CONSERVATION

## UPOTREBA LASERA U KONZERVACIJI PAPIRA

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### *Summary*

The authors of this article describe and discuss about analytical laser THUNDER ART technique applied to the diagnostics of archival art work on paper in the case study of Architectural Blueprint done by Nikola Krasnov (1864-1939) that belongs to the collection of The Archives of Yugoslavia.

Authors particularly wanted to characterize laser cleaning as comfortable and effective technique for the process of impurities removal in the conservation of works on paper. Obtained results had shown that green wavelength had removed only re-painted parts of colors, mostly red and black.

*Keywords:* artworks on paper, architectural blueprints, conservation, laser cleaning, Nikola Krasnov

### *Sažetak*

U ovom radu razmatra se upotreba lasera u konzervaciji papira na primjeru arhitektonskog crteža na ozalidu arhitekta Nikole Krasnova (1864.-1939.) koji se čuva u Arhivu Jugoslavije u Beogradu. Crtež je čišćen laserom THUNDER ART sa sve tri valne dužine, a najbolje se pokazala zelena koja je uklonila upravo preslikane dijelove boja, ponajviše crvenu i crnu, zbog kojih je i provedeno ovo čišćenje.

Autori zaključuju da je lasersko čišćenje udobna i učinkovita tehnika uklanjanja nečistoća u postupku konzervacije djela na papiru.

*Ključne riječi:* umjetnine na papiru, arhitektonski nacrti, konzervacija, lasersko čišćenje, Nikola Krasnov

### **Introduction**

International exhibition dedicated to the 150th Birth anniversary of Nikola Krasnov will be held in December in 2014 in Moscow and also jubilee will be celebrated in Belgrade in January 2015. The exhibition is dedicated to the life and work of architect Nikola Krasnov, who on the initiative of HM King Alexander I, in the period between the two World Wars, started building the Royal Compound in Belgrade. Krasnov, formerly a Russian imperial architect, he worked between the First World War and Second World War in the Ministry of Construction of Kingdom of Yugoslavia, designed the look of the capital and several towns in Serbia.

The international exhibition will be organized by the Archives of Yugoslavia, supported by the House of the Russian Diaspora “Alexander Solzhenitsyn” and the Historical Archives of the City of Belgrade. The Nikola Krasnov reprint (Architectural Blueprint) from archival documents from Archives of Yugoslavia were subject of extensive art historical and scientific investigations at the Central Institute for Conservation in Belgrade (CIK).

The results that were obtained after successful research on laser cleaning that were done in the collaboration between the Archives of Yugoslavia and CIK had shown that there is a need to utilise the laser cleaning of artworks on paper, considering that the use of this analytical technique is still at the beginig in the Republic of Serbia.

## **Laser cleaning of paper**

Laser cleaning has a number of advantages over more traditional methods of cleaning. Laser cleaning techniques are non-contact since the energy is delivered as light. It is selective – by choosing a wavelength which is absorbed strongly by the dirt, but only weakly by the underlying surface. It has localized action, because it is effective just in the zone where the laser beam is focused. The immediate control and immediate feedback are also very important features, since conservator is able to immediately stop the process of ablation, but at the same time the effect of cleaning is immediately visible. Laser cleaning is also environmentally friendly technique. Since the late 1980s the use of the laser in conservation has become more widespread. Commercial laser systems are now available and are used on a routine basis in a number of conservation works in Europe and worldwide.<sup>1</sup>

## **Materials and methods**

### *Applied technique*

The type of laser used at the Central Institute for Conservation in Belgrade is the most recent version of system for laser cleaning produced by “Quanta System”, Milan, Italy. The model is “Thunder Art” and it works under “Q switched” mode. This advanced solid-state laser uses Nd:YAG, neodymium-doped yttrium aluminium garnet; Nd:Y3Al5O12, as a crystal. This type of laser system operates with wavelengths ranging from ultraviolet through visible to infrared spectrum: 1064 nm with energy of 900 mJ; 532nm with energy of 400 mJ; 355 nm with energy of 250 mJ. The laser beam has 10 mm; the frequency of the pulses is 20Hz. The beam is led through a laser arm, designed to easily aim and reach any part of the object that is to be cleaned. Laser wave is focused, with a focal distance of 1m.

### *Laser cleaning of paper*

The cleaning process is very sensitive because of the structure of collagen fibres parchment paper, which are mixed with the material to be removed, and

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<sup>1</sup> Cooper, M. Laser cleaning in conservation: an introduction. Oxford, 1998.

the sensitivity to radiation used inks and pigments for writing or designs.<sup>2</sup> The treatment with a Nd:YAG laser at 532 nm showed to be suitable for laser cleaning which caused no degradation of paper when using the proper fluence.<sup>3</sup>

Since the paper itself is sensitive organic material, therefore the laser cleaning experiments were applied on different types of stains, variety of paper, white and black surfaces, stone and golden leaves surfaces. These analyses were conducted in order of comparison of traditional conservation methods of works on paper and application of laser cleaning.

### **Laser cleaning of the Architectural Blueprint**

The Architectural Blueprint was done on specific printing paper called "ozalid", it belongs to archival documentation of AJ-62 Ministry of Construction of Kingdom of Yugoslavia. The Blueprints depicts decorative intersection of the Chapel Monument at Zejtinliku.

Dimensions of this archival document is 100 cm x 138 cm, blueprint has been arranged and preserved in archival envelope. The Architectural Blueprint was painted by tempera technique and underlined by a graphite pencil. By observing the Architectural Blueprint we had found that the Handwriting of the architect was done by black and green ink. Other materials that were used while drawing this blueprint are blue and red pencil for printing, graphite pencil and also black and violet stamp are visible.

Due to inadequate preservation and storage of the Architectural Blueprint, we determined that the paper had undergone enormous damage in form of deformation, tears and missing parts, it had weakened because of the folding. In addition to the presence of mechanical damage, the physical and chemical devastation is also present, the paper has yellowed, stains are visible.

Paint layer had cracked on the area where paper was folded. Golden paint has oxidized on the central part of the blueprint (on the left side of the Cruci-

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<sup>2</sup> Simileanu, M.; G. Avgerinidou; L. Angheluta; R. Radvan; L. Miu; J. Striber, Laser cleaning of XVIIIth C. parchment with polychrome inscriptions. // *Optoelectronics and Advanced Materials – Rapid Communications*, Volume 2, Number 9, 587-592.

<sup>3</sup> Kolar, Jana; Matija Strlic, Doris Muller-Hesse, Andreas Gruberc, Karin Troschkec, Simone Pentziend, Wolfgang Kautek. Near-UV and visible pulsed laser interaction with paper. // *J. Cult. Heritage* 1 (2000) S221–S224 © 2000 Editions scientifiques et médicales Elsevier SAS. All rights reserved S1296- 2074( 00) 00149-7:FLA)

fiction). Same change has been determined on the part where the Sky is depicted. Under the Crucifixion where Christ Pantocrator was painted we found that the paint layer has darkened.

## Results

The Architectural Blueprint was cleaned by laser THUNDER ART with three different wavelengths. After obtained results it was determined that green wavelength had removed only repainted parts of colors, mostly red and black (Figure 1-3). The use of lasers had shown as efficient: intense red and black patches on the left side of the paper were almost completely removed. Traditional conservation methods has shown unsatisfactory, therefore we applied laser cleaning on the object. In this case we had excluded Chemical methods because of the unstable paint film.



Figure 1-3

## **Conclusion**

The rescue of Nikola Krasnov's Architectural Blueprint represents a case study of demonstrating the necessity for Laser cleaning must be considered as an advanced tool applied in cases where traditional techniques may be inadequate.

## **Acknowledgements**

The authors thanks to Archives of Yugoslavia in Belgrade on a successful collaboration during the research on application of laser cleaning of works on paper. The obtained results gave us an opportunity to utilise the use of lasers in the conservation of paper. These results are important in the field of conservation of work on paper. The importance of obtained results and the use of new techniques in the protection of Cultural Heritage it is priceless.