

LASER APPLICATION IN PROCESING, TECHNOLOGY, CONSERVATION AND EXPERIENCE OF ARTWORK BASED ON LIGHT METALS

MILESA SREĆKOVIĆ¹, BILJANA TIMOTIJEVIĆ¹, VLADIMIR
ARSOSKI¹, SUZANA POLIĆ-RADOVANOVIĆ², MIROSLAV
TIMOTIJEVIĆ³, ALEKSANDER KOVAČEVIĆ⁴, ANĐELKA
MILOSAVLJEVIĆ⁵

¹Faculty of Electrical Engineering, University of Belgrade, Belgrade,
²Yugoslav Institute for Bibliography and Information, Belgrade, ³Faculty of
Philosophy, University of Belgrade, Belgrade, ⁴Institute of Physics, Zemun-
Belgrade, ⁵Faculty of Mechanical Engineering, University of Belgrade,
Belgrade, Serbia and Montenegro

ABSTRACT

Application of lasers in fine arts, in connection even with light metals, exists almost half a century. Due to multifold role of lasers, only few approaches, showing either potential applications or applications already implemented on this type of materials, is shown in this work.

Keywords: laser, light metals, fine arts, holography

1. INTRODUCTION

Application of lasers in fine arts is a subject interesting by itself. Without the tendency to elaborate all possible approaches, we have chosen several short analysis and potential applications about the place and the role of laser technics to present in this work.

2. ILLUMINATION

The main experience in fine arts is use of visual effects. Laser techniques could bring a new quality for the artwork. The illumination by natural as well as artificial sources visualizes only non-coherent effects, which have less possibilities to perform interference.

The illumination by coherent light of various wavelength (Ar⁺ ion on 514.5 nm, second and third harmonics of Nd³⁺:YAG) would expose new dimensions of artworks that have relief or wire structure (Fig. 1) [1].

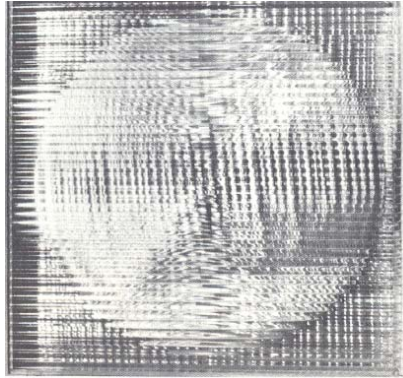


Fig. 1. HEINZ MACK (b. 1931). Silver-Dynamo.

Aluminium and glass, With Motorised rotor. 1960.

Particularly, objective facts show that surfaces of different quality of processing have different speckle patterns.

3. THE ROLE OF HOLOGRAPHY

The internal connectivity of holography is multifold. For instance, in museums of holography, there are art-works having one part presented by a hologram (an apple in Musee d'Holography, Paris). There are also full holograms of artworks made in order to preserve the object [2]. Holographic methods of control and monitoring enable us to obtain the image of possible weak points (through centuries) of particular part of the construction. The methods could be the last circle in the chain of control method where others are: interferometry, photoelasticity, polarimetry, ellipsometry. If one takes into consideration the polarization properties of light – the properties that exist in the light originated from the most of laser sources – then the operation is much more eased (Fig. 2).

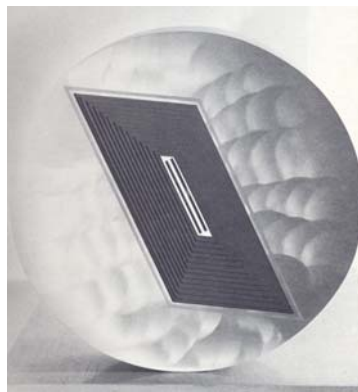


Fig. 2. TONY DE LAP. Arje. Aluminium, board, Plexiglas and lacquer. 1964. Dilexi Gallery, La Jolla.

4. THE ROLE OF LASER TECHNOLOGIES

Imagined artwork must cut deeper into technologies of higher “roughness”. In the history of fine arts, there are many examples that using old technologies made monumental artwork construction timely.

The implementation of lasers eases the work very much, especially if one needs to have many repliques (copies) of the object. In the case of reproduction of objects by other technologies, techniques with effects of coherent light determine the authenticity.

The object details are relief or made of pieces of tin or wire. To make details, laser processing tasks could be implemented: laser cutting of Al foil, drilling of small holes, welding of wires and thus making constructions. The laser processing of aluminium is a difficult task; it took many years to solve it. Nowadays, many data of cutting speed, beam energy for welding, etc., exist. Possibilities for underwater welding is also present [3]. However, approaches using thermal equation significantly depend on pulse length. Some approaches that are implemented for longer pulses (at least 10^3 times longer than picosecond), require new consideration.

In order to prepare the object in required manner for processing, implementation of special pulses having complex time structure is necessary. The surface of the object is covered with various materials, which better absorb the implemented laser wavelength. Therefore, dusts and layers obtain special role. In Figs. 2, 3 and 4 artworks having cutting elements are presented [1]. Relief structure of the material could be obtained either by change of the intensity distribution over the beam profile or by laser prototyping (used on other objects).



Fig. 3. *EDUARDO PAOLOZZI (b. 1924). Hermaphroditic Idol No. 1. Aluminium. 1962. Museu de Arte Moderna, São Paulo.*

5. THE ROLE OF LIGHT METALS IN DYES

The implementation of dyes as compounds of light metals (Mn, Ti and Al), in the form of oxides, sulphates is widespread in fine arts. Considering the monochromaticity of laser beam, laser sources have special role in standardization of color as well as in setting up the objective colorimetric and trichromatic coordinates for particular color [5].

As TV plays a great role in arts, the criteria of color definitions, including medical senses and laser implementation in HDTV, are also present.



Fig. 4. ZOLTAN KEMENY (1907-1965). *Trois Vents. Coloured aluminium. 1963. Baron Lambert Collection, Brussels.*

6. CORROSION AND MICROSPECTRAL ANALYSES

By monitoring the quantity of the material ejected from the microscopical sample, and implementing the sophisticated laser linear and nonlinear spectroscopy techniques, we obtain new solutions (Fig. 5.). The problems of corrosion and rust have been usually solved by implementation of laser-material interaction effects (Fig. 6.) [6].

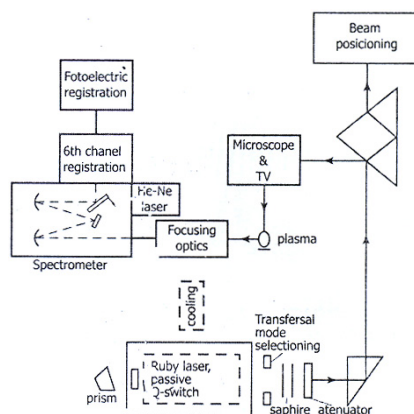


Fig. 5. *Laser spectral microanalyser*

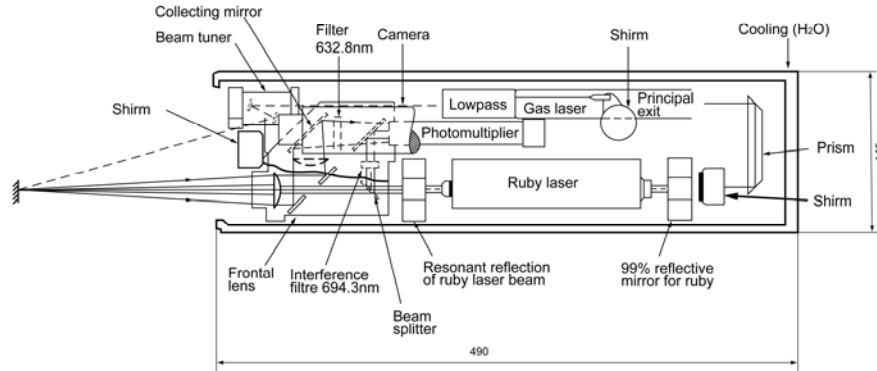


Fig. 6. Corrosion test laser device

7. ALLOYING PROCESSES

Implementation of laser methods for obtaining fine powders has special features. When to use the term “nanomaterial” is still opened for discussion. The authors have exposed PMMA and polycarbonates, covered with thin powder layers to ruby and other pulsed laser beams. The powder materials with light metals have been indented into some plastic materials. The scanning techniques enable the possibility to cover greater areas.

Analyses of obtained microscopical damage (by using EDX or other beam techniques) lead to estimation of the material composition as well as the rust depth.

Finally, in spite of the peculiarity, one of the principal laser applications in art is dust cleaning of artwork metal surfaces or removal of metal traces from ceramic surfaces [7].

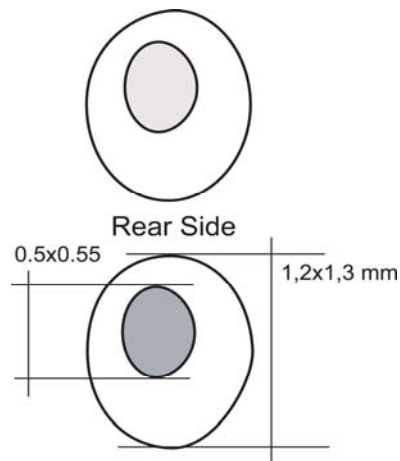


Fig. 7. High purity Al-pulse laser treatment [10]

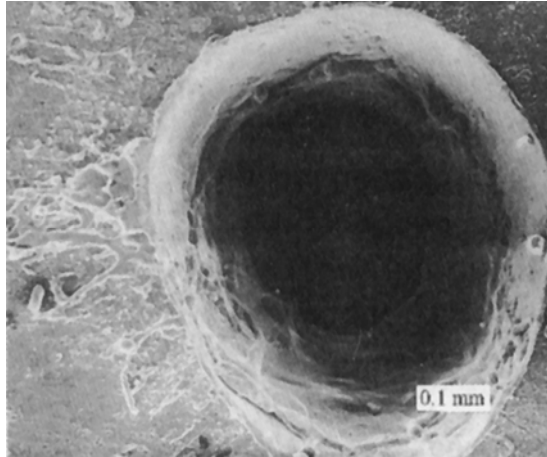


Fig. 8. SEM micrograph of Al treatment with ruby laser (1.4 J) [8].

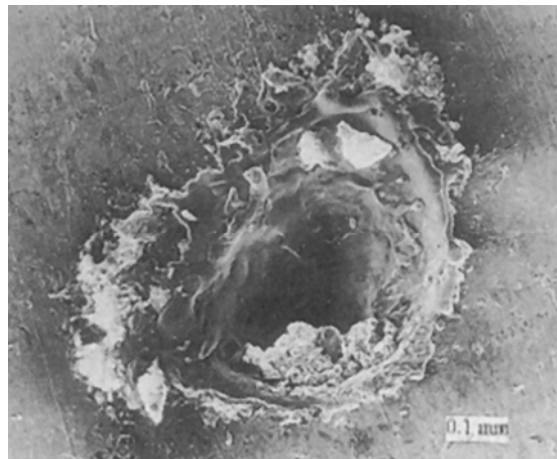


Fig. 9. SEM micrograph of Al treatment with ruby laser (0.4 J) [8].

Some results of interactions between laser beam and aluminium (or titanium) alloys as well as pure materials are presented in Figs. 7, 8 and 9 as well as the recording of provoked acoustical effects in frequency and time domain (Figs. 10 and 11.). The processing modes and ambient parameters significantly influence the results [8].

The laser assisted control of drawing fine wires (fibers) is an elegant solution based on diffraction effects.

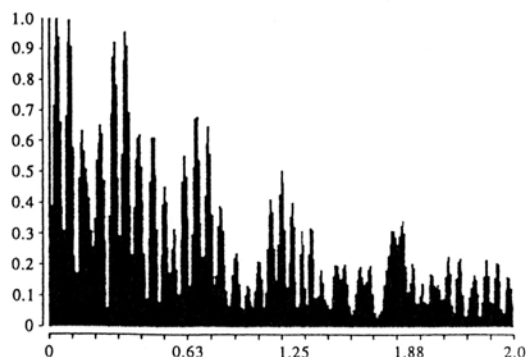


Fig. 10. *Ti-acoustic recording, frequency domain [11]*

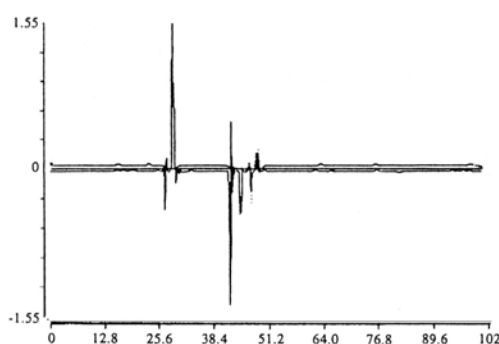


Fig. 11. *Ti-acoustic recording, time domain.*

8. CONCLUSION

We assumed that the implementation of the term “multifold” will correctly describe potential and present laser implementations in correlation with fine arts using light metals (Al) or alloys. The names of the developed laser devices for fine art purposes: Palladio II, Michelangelo, Raffaello, Leonardo speak for themselves. [9, 10] The other role in correlations, in dye compounds, Al, Mn, Ti and other light metals play different roles.

REFERENCES

- [1] Larousse Encyclopedia of Modern Art from 1800 to the Present Day, Art and Mankind, Hamlyn, London, New York, Sidney, Toronto, 1984.
- [2] a) The Engineering User of Holography, Cambridge University Press, Editors: E.R. Robertson, J.M. Harvey, sep. 1968. b) J. Butters, Holography and its technology, Peter Peregrinus Ltd. London 1971. c) M. Francon, Optical Interferometry, Academic Press, New York–London 1966.

- [3] V.F. Kvasnicki, *Specialnie Sposobi Svarki i Paiki*, Sudostroenie, Leningrad, 1984.
- [4] Yu.V. Aphanasev, O.N. Krohin, *Gasodinamicheskaya Teoria Vozdeistvya Izlucheniya Lasera na Kondenzinovanie Veschestva*, *Kvantovaya Radiofizika*, (1970) pp. 122-170.
- [5] *RGB Pulsed Lasers*, Prospect.
- [6] M. Srećković, M. Petrović, *Daljinsko merenje korozije upotrebom laserske tehnologije*, *Tehnika*, XLVI TO 5, 1991, TO5-9.
- [7] N. Huet, E. Tanguy, A. Vinçotte, "Using lasers for cleaning and plaster patrimonial objects", *Cost Workshop on Laser Cleaning of Artworks*, Lisbon, 2003, pp. 12-17 (Zn).
- [8] A. Milosavljević, M. Srećković, V. Milenković, B. Ilić-Paul, P. Citaković, S. Ristić, *Aluminium*, 73 (1997) 6.
- [9] *Pulizia Laser, Bleu line*, Prospect (Verde, 1, 064) modele Palladio, Michelangelo, Raffaello, Leonardo
- [10] M. Srećković, V. Šijački Žeravčić et al., *Rev. Roum. Phys*, 34 (1989) 1081.
- [11] M. Srećković, S. Ristić, M. Hribšek, D. Grozdanovski, *ICA 14*, C9-10, Beijing 1992.