APPLICATION OF LASER BEAM FOR CLEANING OF GYPSUM SCULPTURES

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Preservation of cultural legacy is essential for ensuring its availability for future generations. Long-term indoor storage can sometimes cause gypsum sculptures to crumble, and thus, there emerges the need for removal of this type of stains. In this paper, gypsum sculptures were cleaned using two lasers in pulsed regime at 532 nm wavelength and continuous regime at 552 nm wavelength. The sculpture was cleaned while retaining its original appearance.

Keywords: laser, gypsum, spectrophotometry, scanning electron microscope, SEM, optical microscopy.

Lasers have been used over the recent decades for various applications such as welding, cutting, surface modification, drilling, etc. One of the new areas in the application of laser-based techniques is laser cleaning of various surfaces. Laser cleaning can be considered a well-established stone preservation technique. Laser removal of unwanted material from objects and monuments is a complex process, closely dependent on the material properties and laser parameters.

Nd:YAG Q-switched laser irradiation at 1064 nm using black lamps results in significant yellowing of gypsum substrates. In this paper, gypsum sculptures were exposed to the nanosecond Nd:IAG laser Thunder Art manufactured by Quanta System and a continuous nonpolarized semiconductor laser with an integrated collimator MGL-S-532 from CNI.

Fig. 1 shows the experimental setup. The irradiated surfaces were examined by spectrophotometer, optical microscope and scanning electron microscope.

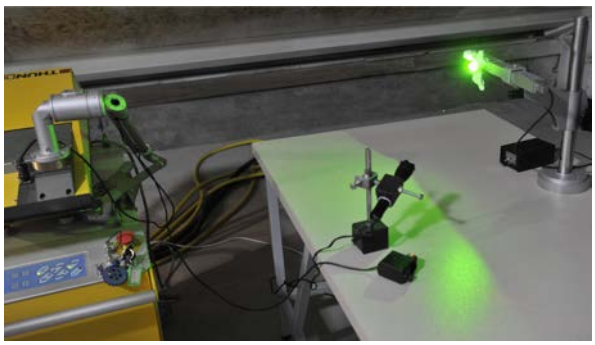

Fig. 1. Experimental setup

Fig. 2 shows the transition between the surface of the gypsum treated with an IR laser (left) and the surface treated simultaneously with an IR and a green laser (right). The image was taken with an optical microscope. It can be noticed that the laser has successfully removed the dirt from the plaster surfaces.

Fig. 3 shows the treated area taken by scanning electron microscope with results of energy dispersive spectroscopy. The results show the increased content of Mg and O_2 on the surface treated with the IR laser which suggests Mg oxides forming. This phenomenon causes the color change of the gypsum surface.

Fig. 2. Micrograph of laser treated surface of gypsum sculpture

a) b)

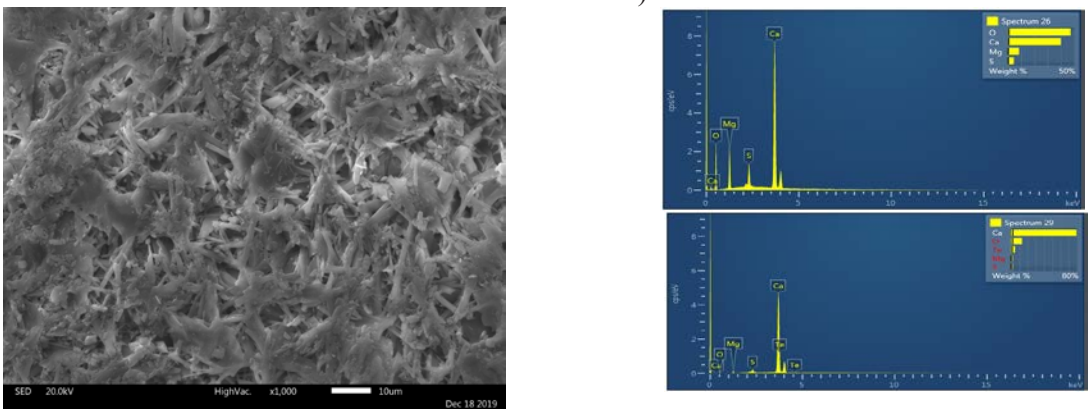

Fig. 3. Image of laser irradiated area taken by scanning electron microscope (*a*) and energy dispersive spectroscopy results in Spect. 26 and 29 (*b*)

Results presented in this work show that surface stains from gypsum sculptures can be successfully removed using optimized parameters in two different laser regimes.

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Застосування лазера для очистки гіпсових скульптур

Збереження культурної спадщини необхідно для забезпечення його доступності для майбутніх поколінь. Тривале зберігання в приміщенні іноді може привести до того, що гіпсові скульптури обсипаються, що викликає необхідність видалення утворюваних таким чином плям. У даній роботі використане лазерне очищення гіпсових скульптур із застосуванням двох лазерів у імпульсному режимі на довжині хвилі 532 нм і в безперервному режимі на довжині хвилі 552 нм. Очищена скульптура зберегла свій первісний вигляд.

Ключові слова: лазер, гіпс, спектрофотометрія, скануючий електронний мікроскоп, оптична мікроскопія.