Simultaneous UV–IR Nd:YAG Laser Cleaning of Leather Artifacts


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Summary. Ancient leather samples from original upholstered furniture were treated with nanosecond Nd:YAG laser radiation with wavelengths of 1,064, 532, and 266 nm. The novel approach was the simultaneous application of these wavelengths. It opened new approaches for laser cleaning leather. Extensive diagnostics such as absorbance of different layers of leather, chemical composition and microscopic inspection studies before and after cleaning were conducted. Advantageous results with simultaneous UV–IR (266 nm + 1,064 nm) radiation are presented and discussed.

26.1 Introduction

Laser cleaning of biogenetic artifacts has concentrated mainly on painting varnish, paper, and parchment in recent years [1–5]. In this context, best results for the removal of dark contaminants from, for example, cellulose and collagen materials were observed with visible laser radiation (532 nm) allowing maximum contrast between the light absorption of foreign materials and the substrate [4, 5]. Leather processing such as laser engraving and marking, in contrast to cleaning, has been developed to an industrial process relying on the in-depth ablation of the substrate.

In this chapter, results optimized multiwavelength conditions of laser cleaning dark contaminants on a leather surface with a Nd:YAG laser are presented.
26.2 Experimental Methods

The prototype Nd:YAG laser cleaning system [6, 7] employed in this study allows the spatial and temporal overlap of the fundamental beam (1.064 nm, up to 300–500 mJ) with its second (532 nm, up to 800 mJ), and fourth (266 nm, up to 300 mJ) harmonic frequencies. The absorbance spectra measurements of leather samples were performed by a Varian Cary 500 spectrometer. The cleaning results were evaluated with an optical microscope (Stemi 2000-C) and a scanning electron microscope (JEOL 840, Stereoscan-360 with EDX-Spectrometer AN-10000). The colorimetric investigations were conducted following the standards indicated by a microspectrophotometer (MPV-SP, Leitz). In these investigations three light sources (A – incandescent lamp, C – daylight lamp, D65 – luminescent lamp) were used. The study of the elemental composition of different layers of leather samples before and after cleaning was conducted by the methods of local X-ray spectral analysis on a raster-type electronic microscope (S-360 with an AN-10000 analyzer) and by secondary-ion mass spectroscopy (IMS-4F, CAMECA). The following parameters were employed: primary ions O$_2^+$, Cs$^+$; element range from H to U; depth resolution of 5–30 nm.

26.3 Results and Discussion

Ancient leather samples from original upholstered furniture were laser treated (Fig. 26.1). A schematic structure of leather samples is shown in Fig. 26.2. The

Fig. 26.1. Original leather samples from an upholstered furniture. Austrian Museum of Applied Arts/Contemporary Art (MAK), Vienna