Evaluation of Effectivenes of Tanned Leather Cleaning with SEM-EDX and FTIR Spectroscopy

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Introduction: Leather has been traditionally used in various everyday applications and art objects since antiquity. Industrial processes such as the various types of tanning have increased the applicability of this material. However, it is still considered as one of the most sensitive materials towards environmental hazards, hard use, etc. Techniques for leather cleaning involve the use of various solvents, soaps and detergents, surface dry-cleaners, etc. Most of the research work done so far on the use of these media aimed basically at the effectiveness of leather surface cleaning. The present work aims at a spectroscopic (FTIR, FTIR-microscopy and SEM-EDX) evaluation of the possible effects of various cleaning procedures on leather as a result of physical/chemical interaction of the medium with the protein material, as well as with any added compounds present.

Experimental: An FTIR spectrometer (PE Spectrum GX) was used for the analysis of KBr tablets of powdered samples scraped directly from the leather surface. A PE AutoImage FTIR microscopy accessory, coupled to the basic unit (reflectance mode), was used in the case of cross-sections and surface detection. SEM was used (Jeol JSM-5310 with a Link Pentafet detector) on graphitized leather samples. Tanned goat leather samples (approx. 2×1 cm) were used in all cases, with no further aging process.

Results and Discussion: Leather samples were cleaned in one part, leaving almost half of the surface in a non-cleaned state for comparison purposes. Cleaning media used: solvents (white spirit, trichloroethane, acetone, alcohol-water mixture), acidic and alkaline media (hydrochloric acid, aqueous ammonia solution), water-based detergents (Texapon®, Synperonic N®), a hydro-carbon-based detergent (Vulpex® in white spirit) and a natural rubber-based surface dry-cleaner (Groomstick®).

FTIR spectra (KBr samples and microscopy) were examined comparatively between adjacent cleaned and non-cleaned areas on each of the tested leather samples. A small shift in the expected amide I vibration was detected in all ono-cleaned samples, along with the detection of small amounts of tannin, ester-type compounds (presumably, oils) and ketone carbonyls. In the cleaned samples, the most notable changes were observed in the case of acetone, ammonia solution and ethanol-water (reduction of esters and protein-related components), trichloroethane (reduction of protein-related components), and Vulpex® in white spirit (reduction of hydrocarbon chains and ketones, see Figure 1).

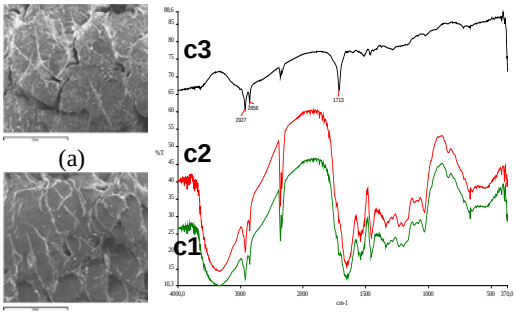

Figure 1: Leather cleaned with Vulpex®/white spirit: SEM image (a) before, and (b) after cleaning; (c) FTIR spectra before (c1) and after cleaning (c2) and the resulting difference spectrum (c3).

Analysis of cleaned leather surface, with SEM-EDX showed significant increase of Cl for hydrochloric acid - cleaned surface, Na for Texapon® and K for Vulpex®. Finally, small increase of S, K, Ca and Si and appearance (low levels) of Na, Si and Cl was detected in the case of Groomstick®.

Conclusions: FTIR spectroscopy and SEM-EDX were employed to investigate the alterations on the surface of tanned goat skin induced by a number of cleaning media. Detergent in non-polar solvent (white spirit) and solutions of extreme pH values (HCl and NH_3) have been found to cause chemical alterations on components of leather surface.

References: 1. Larsen R., 1995, "Fundamental Aspects of the Deterioration of Vegetable Tanned Leather", PhD Thesis, The Royal Danish Academy of Fine Arts, School of Conservation, Copenhagen.

2. European Commission, Directorate- General XII Environment and Climate Programme, 1999, "Methods in the Analysis of the Deterioration of Collagen based Historical Materials in relation to Conservation and Storage", Preprints, Advanced Study Course, 6-10 July 1999, School of Conservation, Copenhagen, The Royal Danish Academy of Fine Arts.