



How Its Made: Emulsion (Organ) Tanned Leathers

Yueh-Ting Chiu^{1,2}, Aleksandra Popowich², Romare Antrobus², Theanne Schiros^{2,3}, Helen H. Lu², and Julie Arslanoglu¹

¹The Metropolitan Museum of Art, New York, USA

²Biomaterials and Interface Tissue Engineering Laboratory, Department of Biomedical Engineering, Columbia University, New York, USA

³Department of Science and Mathematics, Fashion Institute of Technology, New York, USA

From natural ingredients to present-day chrome tanning, the art of leather making can be found across cultures dating back to prehistoric times, with each process imparting unique properties and chemical markers on the leather they produce. Leather tanning processes manipulate and strengthen the collagen matrix of skin, resulting in a long-lasting material with desirable mechanical characteristics, including durability and malleability. Emulsion tanning is a traditional method using natural emulsifying agents (oils/lipids), generally from the organs (brain or liver) of skinned animals, to preserve skin and has been used by cultures globally because of its efficiency. Despite all that is known of historic leathers, there is currently no scientific method to identify emulsion tanned leathers. Determining the effects of tanning agents on animal skin at the molecular level is critical to understand how structural changes induced by the tanning process affect the chemical and mechanical properties and lifespan of the leather product.

In the 17th century, the Dutch colonization of Taiwan affected the local culture in the form of religion and architecture and introduced European artifacts and practices. Within the collection at the Metropolitan Museum of Art is a pictorial map wall hanging depicting the Taiwanese town of Tainan painted on leather, a technique that may have been exported from Europe by the Dutch. This painting, entitled *Forts Zeelandia and Provinitia and the City of Tainan* is one of several versions depicting the Dutch forts, some of which exist today. This version likely dates from the 19th century, due to the lack of foreign ships and figures signifying the post Dutch colonial-era (>1662) and presence of the city wall built in 1791. The repetition of figures and pictorial elements suggests the use of stamps or stencils and that the wall hanging may have been created in a local workshop for European tastes. The image of the map is executed in ink and colors on a leather support made of several smaller skins stitched together and suspected of being deerskin. The leather itself is free of any tannins or chromic acid, yet remains pale, soft, supple, and malleable, begging the question: is this an example of emulsion tanned leather?

In order to determine the tanning method used on the painted leather in the pictorial map, a series of unique reference materials were created to establish the proteomic fingerprints and lipidomic profiles of different emulsion agents using mass spectrometry (MS). Additionally, material structural studies were performed to compare the chemistry of leathers tanned with different emulsion tanning agents. Further examination using scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDAX), Fourier-transform infrared spectroscopy Imaging (FTIR-I), and X-ray photoelectron spectroscopy (XPS) to shed light on the composition, structural assembly and surface elemental/chemical distribution. Together, the molecular fingerprinting and functional chemical mapping studies will provide new insights into



emulsion tanning, a global phenomenon which remains vastly understudied, and can guide and establish criteria for identifying emulsion tanning methods.