

The Torah Scroll of the National Library of the Kingdom of Morocco: Parchment Support and Black Ink Analytical Study

Authors : Oubelkacem Yacine, El Bast Hassan, El Bakkali Abdelmajid, Lamhasni Taibi, Ettakni Mahmoud, Ait Lyazidi Saadia, Haddad Mustapha, Ben-Ncer Abdelouahed, El Ferrane Mohammed, Boufarra Abdelkrim

Abstract : The present work relates to an on-site and completely non-invasive investigation of one of the most famous west Mediterranean Torah Scroll housed at the National Library of the Kingdom of Morocco. The scroll is 26 m long and consists of 143 parchment sheets of 59 cm x 19 cm, exhibiting only black writings; it is of unknown age. The artifact has been restored by the curator staff of the library. The investigation exploring separately the parchment support and the writing black ink aims at: i) the examination of the parchment conservation/degradation state, ii) the identification of the black ink and iii) the identification of the parchment handcrafting materials. For this purpose, the analyses have been based on combining all of elemental XRF and structural Raman, ATR-FT Infrared Red and Fiber Optical Reflectance spectroscopies, in addition to chroma-metric and pH measurements. pH measurements showing values around 6.5 are in concordance with the absence of any visual corrosion related to the parchment acidity. However, on the basis of the relative intensities and frequency shift of amid I (AI) and amid II (AII) vibrational bands of the collagen, ATR-FTIR spectra revealed diffuse hydrolysis and gelatinization of the parchment writing support; diffuse and non-homogeny degradation by gelatinization has been also confirmed by the IG gelatinization index deduced from the NIR bands on the FOR spectra. This IG index, defined as the ratio $I(6860\text{ cm}^{-1}) / I(6685\text{ cm}^{-1})$, ranges in the interval 0.98 - 1 and highlights collagen degradation at the molecular level. Sequentially Shifted Excitation Raman measurements (SSERS) crossed to X-ray fluorescence (XRF) ones on the black writings revealed that the black ink used is an iron-copper gall one, while FOR spectra are typical of pure metal gall inks. These later reflectance measurements exclude, thus, any intentional addition of carbon black to the ink recipe. Moreover, no lead white had been used while pre-drawing the writing lines. On another side, ATR-FTIR measurements highlighted the presence of oxalates as ink degradation products. Considering the parchment handcrafting, the combination of XRF and ATR-FTIR measurements led to the assumption that this writing support had been prepared according to ancient Middle East practices; the parchment infrared fingerprint seems identical to that of the Dead Sea scroll. The present multi-technical analyses are the first ones performed on an ancient Judaic written parchment of Morocco; it is under furthering. The investigation will be extended to other parchments belonging to the Jewish Cultural Heritage Museum of Morocco in Casablanca.

Keywords : torah scroll, parchment, black ink, non-invasive analyses, XRF/ATR-FTIR/RAMAN/FORS

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