

# Book of Abstracts

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## Spectroscopic analysis of pigments and inks in three Byzantine manuscripts

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In the course of our study of Byzantine manuscripts, three Greco-Byzantine manuscripts, *Four Gospels* (10<sup>th</sup> century), *Four Gospels* (12<sup>th</sup>-14<sup>th</sup> centuries) and *Psalter* (18<sup>th</sup> century) were analyzed. They are written on parchment/paper, with Greek alphabet and richly decorated with gold writing, miniature ornaments and ornamented initial letters.

Micro-Raman spectroscopy, FT-infrared spectroscopy and SEM-EDS, were used in analysis of the pigments and inks in the manuscripts. Micro-Raman spectroscopy allowed fast and *in situ* analysis of majority of pigments and inks, except for the red organic pigment, and metallic pigments (silver and gold). SEM-EDX was used in analysis of the silver and gold pigments while ATR- FTIR spectroscopy revealed the nature of the organic red pigment.

The analysis showed that in the 10<sup>th</sup> and 12<sup>th</sup> century manuscripts pigments were identical while in 18<sup>th</sup> century manuscript differentiation was observed. Inks differ in all three books. Gall ink was identified as black-brown ink in the 10<sup>th</sup> century books; logwood was used in 18<sup>th</sup> century manuscript while goethite was identified in the 12<sup>th</sup> century manuscript. Beside dark ink, gold was extensively used as ink in all three manuscripts as well as red organic pigment, most probably madder.

The most interesting find was the green paint in the 10<sup>th</sup> and 12<sup>th</sup> century manuscripts which is a mixture of lazurite and lead tin yellow type II. The yellow pigment was not in use in Europe prior to 1300 A.D. Although refurbishment of the decorations in the later period could not be excluded, there is possibility that the use of lead tin yellow type II in Byzantine countries started much earlier than generally accepted.

**Keywords:** *Byzantine manuscripts, pigments, inks, micro-Raman spectroscopy, FTIR*