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L'Avventuroso 1936 project: the first analytical approach to printed historic Italian comics

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***Abstract* – The history of modern European comics began in the first half of the 19th century, as a representation of ideas by images, often combined with text or other visual information. The object of this research is represented by an issue of the Nerbini comics series "L'avventuroso", pressed in 1936. For the first time, non-invasive diagnostic techniques were used to identify the materials of the support and of the coloured substances adopted in printed comics publications. The multi-analytical campaign combined visible-UV photography, FTIR in μATR mode, and XRF (single point and mapping).**

I. INTRODUCTION

Comics allow artists to express ideas in a different and unique way if compared with other artworks. For these reasons, original hand-drawn pages and historic printed comics should be considered in some cases object of artistic and cultural relevance, needing appropriate conservation methods. Comics was born in the United States in 1895, when Joseph Pulitzer [1], editor of "The World" newspaper in New York, decided to add a colour illustrated supplement for children to the Sunday editions: the stories of "Yellow Kid", designed by Richard Felton Outcault. The stories were immediately successful. This led to the multiplication of comics stories mostly of a comic nature for children entertainment. It is precisely from purely comic plots, in fact, that comics took their name [1]. From the end of the 1920s, in addition to comic books aimed purely at children, other adventurous appeared. The most known are Tim & Spud (1928), Flash Gordon (1934), Secret agent X-9 (1934), Mandrake the Magician (1934), Superman (1938), Batman (1939), The Spirit (1940), Brenda Starr (1941), Captain America (1941), Wonder Woman (1942) [2].

In Italy, the adventurous genre was not long in appearing and spreading rapidly, especially thanks to the Nerbini publishing house. Nerbini was founded in 1897 in Florence and was one of the first publishing houses to spread a large number of comics weeklies from the 1930s. The most known are L'Audace e L'Avventuroso (1934), l'Intrepido, I 3 Porcellini, il Giornale di Cino e Franco (1935), Il Vittorioso e Paperino (1937) e Giungla (1938) [3]. In particular, "L'Avventuroso" was launched starting on October 14, 1934 and immediately reached high numbers of sales, up to 500,000 weekly copies. Following the outbreak of the Second World War, the publication edited by Nerbini continued until February 28, 1943. Due to economic problems, the publishing house was forced to sell the newspaper to Mondadori who decided to suspend definitively the publication in May 1943, after 450 issues [4].

The illustrated paper represents a peculiar class of materials from the conservative point of view due to the brittleness of the supports and to the colour fading [5]. In particular, the paper used in the decade between 1935 and 1945 is certainly even less suitable for conservation, due to the use of poorly refined wood pulp obtained by increasingly cheaper chemical systems [6].

In the present work, the first dedicated to historical comics, the coloured cover of the issue 102 published on September 20, 1936 (Fig. 1) was investigated. A multi-analytical campaign combining UV-induced fluorescence photography, FTIR in μATR mode, and XRF (single point and Mapping), conducted by non-invasive instrumentation, led us (i) to evaluate in depth the state of conservation of the finds and to (ii) characterize the main pigments involved in the historical colour printing process.

Fig 1. Visible (above) and UV (below) images of the issue 102 cover (1936)

II. MATERIALS AND METHODS

The findings were subjected to preliminary investigations by means of photographic imaging techniques, documenting the state of conservation of the substrate and printing materials and identifying any alteration phenomena and / or biological attack. The images were acquired using a Nikon D90 photographic device, illuminating the subject with chromatically calibrated (5000 K) light for visible light acquisitions and Wood lamps (peak at 365 nm) for observations of fluorescence induced by UV light.

For observations of details not visible to the naked eye, an SZP-FL Optika Italia stereomicroscope was used (100 W mercury vapor UV lamp).

The images were acquired by means of OPTIKAM PRO 5 camera (2560x1920 pixel, 5.0 Mpixel). Therefore, the imaging techniques were used to identify the areas for the subsequent spectroscopic investigations.

In order to better characterize the paper substrate and the nature of the printing inks, X-ray fluorescence spectrometers (XRF) and infrared Fourier Transform spectrophotometry (FTIR) were used. The study of the elemental composition was carried out with XRF, both on single spots and on areas by means of the mapping mode.

Single spots measurements (3 mm diameter) were performed using the EIS XRS 38 (W anode, SDD sensor, resolution 135 eV at 5,9 keV), 30 kV voltage, 50 µA current intensity, and 60 s acquisition time. Mapping measurements were instead carried out with the portable XRF ELIO XGLab spectrometer (Rh anode, 1.5 mm steps), 40 kV voltage, 80 µA current intensity and 3s acquisition time per point. The acquired heat maps were then elaborated through PyMCA software in order to represent the correlation between the identified elements. The elemental results obtained through XRF are summarized in Table 1.

The study of the molecular composition was conducted using FTIR in attenuated total reflectance mode (µATR). The spectrometer used was a Nicolet iN10 Infrared Microscope (Thermo Scientific), equipped with a liquid nitrogen cooled detector and mounting a µATR Ge crystal tip.

III. RESULTS AND DISCUSSION

A preliminary observation reveals the presence of lacerations, tears, and folds of the paper, probably due to the poor quality of the support and inappropriate storage methods. On the other hand, the printing inks appear in good condition showing no signs of corrosion. The stereomicroscopic images in visible light (Fig. 2) point out the use of the three basic colours (cyan, magenta, yellow) and the black to produce the screening, typical of the four-colour printing.

The FTIR-µATR spectra (Fig. 3, grey lines) collected on the paper substrate show the characteristic bands of cellulose in the range between 1200 and 1000 cm^{-1}.

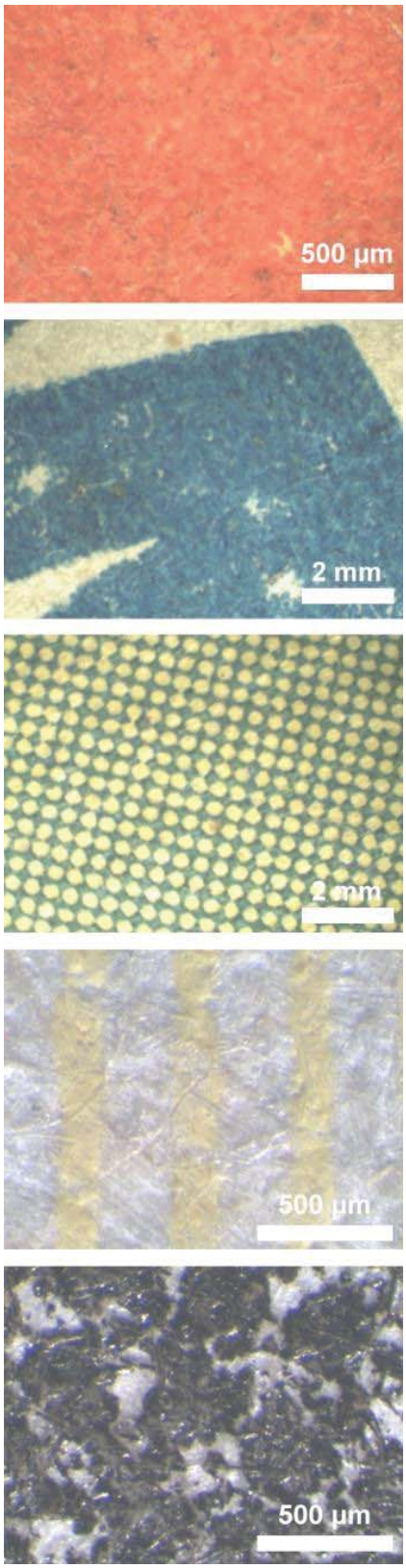

Fig. 2. Stereoscopic images in visible light of the red (above), blue (centre) and green (below) areas of the comics.

Moreover, the wood pulp was pre-treated before the printing processes with carbonates, as highlighted by the band at 1420 cm^{-1} and 870 cm^{-1} and sulphates at 3535 cm^{-1}, 3400 cm^{-1}, and 1620 cm^{-1} [7]. In addition, XRF analysis confirms the presence of sulphur, barium and zinc, ascribable to the presence of a white pigment as lithopone (barium sulphate and zinc sulphide) or barite (barium sulphate) and zinc oxide [8,9], used to whiten the background (Table 1).

As regards the printing materials, yellow pigments are the most abundant: the XRF spectra collected on the header, as well as on the other illustrations, highlight the presence of chrome yellow, as confirmed through the FTIR analysis by the broad band around 850 cm^{-1}, related to CrO_4 stretching (Fig. 3, yellow line) [10]. In addition, XRF analysis revealed high counts of Cobalt, attributable to the use of Fischer's yellow known as aureolin; lead and barium (lead- and barium-based white) were also identified: they were used [10], mixed with the aureolin, to define the half shades (Fig. 4).

Table 1. Elements detected on the different print colour identified on the comics with the related attribution to pigments. Elements highlighted with parentheses were revealed in traces

Colour	Detected elements	Attributed pigment
Yellow	Ca, Ba, Cr, Pb, Co, Zn	Chrome yellow + aureolin + lithopone
Red	Ca, Ba, Cr, Fe, Co, As, Pb, Zn	Iron-based pigments for red, chrome yellow + lithopone + lead oxide
Blue	Ca, Fe	Prussian blue
Green	Ca, Ti, Cr, Fe, Pb	Prussian blue + Chrome yellow
Black	S, Ca, Ba, Cr, Fe, Zn, Pb	Prussian Blue mixed with inorganic fillers
Black Ink	(Fe)	Carbon Black
Paper background	K, Ca, Cr, Ti, Fe, Zn	Lithopone/barite + Zinc oxide

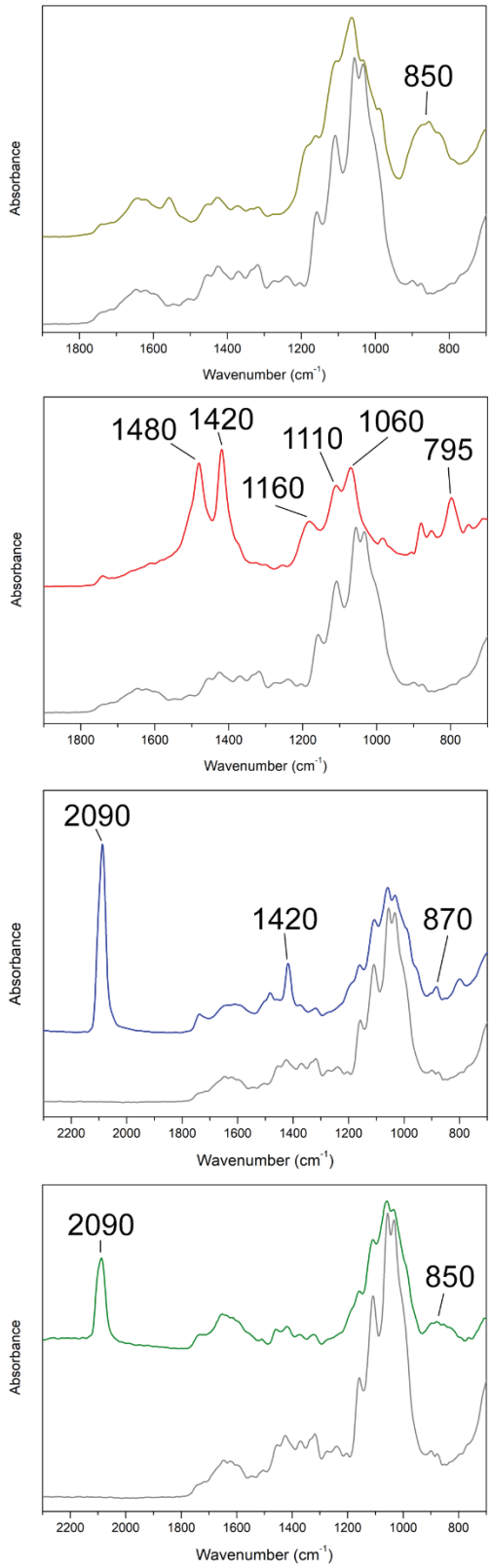

Fig. 3. From the top: IR spectra collected on yellow, red, blue, and green areas. The grey lines are related to the wood-pulp-paper substrate.

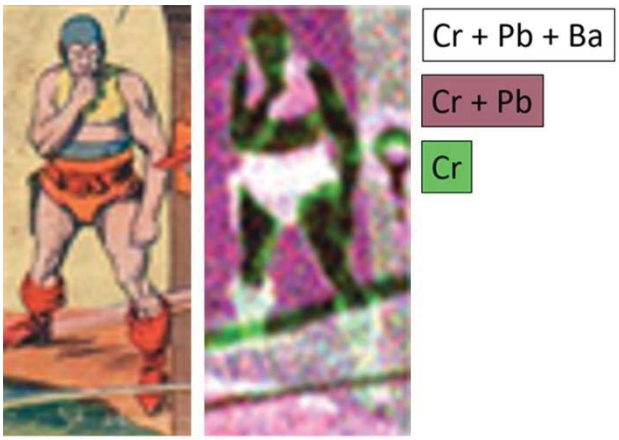

Fig. 4. Visible image (left) and XRF map (right). The black areas are related to the areas with no counts of Cr, Pb or Ba.

The main element identified in red print pigment is iron (Table 1), suggesting the use of iron-based pigments [8]; orange colour is characterized by chrome yellow mixed with lead oxide and lithopone ($BaSO_4$ + ZnS) (Fig. 4). In addition, FTIR-μATR analysis performed on the red areas (Figure 3, red line) highlight the bands of magnesium carbonate at 1480 cm^{-1}, 1420 cm^{-1} and 795 cm^{-1} [12] and barium sulphate at 1160 cm^{-1}, 1110 cm^{-1} and 1060 cm^{-1} [13].

Blue ink was Prussian blue: its presence is documented through the XRF analysis by the iron and through the FTIR investigation by the characteristic $[Fe(C\equiv N)_6]^{3-}$ ion stretching band at 2090 cm^{-1} [12]. In addition, characteristic band of carbonate were identified at 1420 cm^{-1} and 870 cm^{-1} (Fig. 3, blue line) [8]. The green colour was obtained by mixing chrome yellow with Prussian blue, as suggested by the FTIR analysis (Fig. 3, green line). No traces of cobalt were detected in these areas. Lighter green shades are characterized by the presence of sulphur, barium, and zinc, related to the use of lithopone, barite, and zinc oxide [8].

The darkest colour of the header was obtained with Prussian blue mixed with silicates, sulphates, and carbonates as mineral fillers. Conversely, black ink of the text contains traces of Prussian blue: this result suggests the use of carbon black.

IV. CONCLUSIONS

From the results, many information about the characteristics of the support and the colour printing materials were collected: the paper was slightly pre-treated with carbonate and sulphate, probably mixed with lithopone, and contained wood pulp. Cyan/blue and black colours of the illustrations were made by Prussian blue mixed with zinc oxide and carbon black respectively; yellow was Fischer's yellow (aureolin) mixed with chrome yellow; red was made with iron oxide, mixed with chrome

yellow and lead oxide; the green was a mixture of Prussian blue and chrome yellow.

Further analysis will be performed on other later issues of this comics series in order to compare the pigments and verify the state of conservation of the materials. Through this research we want to highlight the importance of such historical artworks, aiming at favouring their recovery and valorization and documenting for the first time the nature of materials used in printed comics.

V. ACKNOWLEDGMENTS

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