

The Colors and Techniques of 17th Century Portuguese *Azulejos*: A Multi-Analytical Study

S. Coentro¹, V. S. F. Muralha¹, A. Lima^{1,2}, A. N. Pais³, A. S. Silva⁴ and J. M. Mimoso⁴

¹ VICARTE: Vidro e Cerâmica para as Artes, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Monte de Caparica, Portugal

² Departamento de Conservação e Restauro, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Monte de Caparica, Portugal

³ Museu Nacional do Azulejo, Rua da Madre de Deus, 4, 1900-312 Lisboa, Portugal

⁴ Laboratório Nacional de Engenharia Civil, Av. do Brasil, 101, 1700-066 Lisboa, Portugal

Azulejos (ceramic glazed tiles) are the most important form of classical decorative art in Portugal.

They have been decorating interior and exterior walls of public and private buildings such as churches, palaces, and even gardens for over 400 years. In the 17th century, Portuguese *azulejo* manufacture was already well established and widespread. The tiles were produced by the majolica technique and had a relatively rich palette which included blue, green, yellow, orange and a set of tones ranging from purple to dark brown.

Only a few scientific studies concerning the chemical characterization of Portuguese glazed tiles have been published [1-5]. This work focuses on the identification of the pigments and pigment mixtures and also on the morphology of color in the lead-tin glaze. A multi-analytical approach was used, with preference for the non-destructive techniques such as energy-dispersive X-ray fluorescence (μ -EDXRF), Raman microscopy and optical microscopy. In selected samples, polished cross-sections were prepared for observation in scanning electron microscope with microanalysis (SEM-EDS), which was used both for the chemical and the morphological studies.

A set of 28 17th century *azulejo* fragments was analyzed, all with white lead-tin glazes.

(...)

This study is a first step towards the knowledge of the 17th century Portuguese *azulejo* manufacturing technology. Hopefully, a broader study will help establishing both geographical provenance and chronology, offering valuable information to art conservators and art historians alike [10].

[1] M. O. Figueiredo et al., *Appl. Phys. A*, 83 (2006) 209

[2] J. P. Veiga and M. O. Figueiredo, *X-Ray Spectrom.*, 37 (2008) 458

[3] J. P. Veiga and M. O. Figueiredo, *Appl. Phys. A*, 92 (2008) 229

[4] M. O. Figueiredo et al., *Nucl. Instrum. Meth. B*, 238 (2005) 134

[5] M. Pereira et al., *J. Nano Res.*, 8 (2009) 79

[6] A. Zucchiatti et al., *Archaeometry*, 48, 1 (2006) 131

[7] C. Sandalinas et al., *J. Raman Spectrosc.*, 37 (2006) 1146

[8] F. Rosi et al., *J. Raman Spectrosc.*, 40 (2009) 107

[9] F. Rosi et al., *J. Raman Spectrosc.*, (2010) (in press)

[10] This work had the support of the National Tile Museum, in Lisbon, Portugal, which provided the samples.