Compositional and microstructural characterization of Celtic silver coins from northern Italy using neutron diffraction analysis

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1. Introduction

The importance of physico-chemical material characterization in studies on the Celtic silver coinage from northern Italy has been rarely considered. Unlike Greek and Roman coins, which have been analysed with several approaches to answer different historical issues, Celtic coins from this area still lack reliable scientific data. Indeed, the few published compositional information [1] have been carried out on untreated coins with X-ray fluorescence (XRF) technique. However, silver–copper alloy coins, especially those with a fineness < 80 wt.% of silver, have actually been demonstrated to be heavily affected by thick silver-surface-enriched layers (up to 200 μm), so data obtained on un-sectioned samples by means of surface techniques, including XRF or PIXE, are not reliable [2–4].

For this reason, a wide characterization project involving the use of neutron-based techniques has been developed. The first compositional results were obtained with Prompt Gamma Activation Analysis (PGAA) and have been recently published [5]. To increase the statistical sample and to investigate also microstructural properties, a bulk and non-destructive technique such as neutron diffraction (ND) has been used in this work for the characterization of a further selection of Celtic coins. Time-of-flight neutron diffraction (TOF-ND) measurements have been performed with the INES diffractometer at the ISIS facility on our specimens.

TOF-ND technique is a powerful tool for the analysis of metal, especially in archaeological studies as precious archaeological artefacts can be analysed in air without any sampling or preparation [6,7]. This technique has been often applied for coin characterization in the last years [8–14], and results were very promising for numismatics studies. TOF-ND analysis is able to provide both compositional and structural information. In particular, the possibility to extract information from diffraction patterns concerning texture index, residual strain and grain dimension, has been considered very useful.

This study had therefore a twofold aim. The first was to provide ratios of precious and base metal (silver and copper respectively), to verify whether a debasement was present among coins dated to different periods and to understand their exchange ratios with foreign currency (e.g. Roman and Massalian currency). The second was to bring new data for the understanding of minting procedures during Iron Age, being documentary evidence absent.

2. Historical background

The pre-Roman coinage from northern Italy, commonly defined as “Celtic coinage of the Po valley”, collects different series of silver coins, produced by several tribes settled in a wide territory known in the subsequent Roman age as the Cisalpine Gaul. These tribes, either of...