The sixteenth-century glass jewellery collection of Archduke Ferdinand II – a great challenge for semi-quantitative XRF investigations

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Introduction

The glass jewellery collection of Archduke Ferdinand II, now on display in the Collection of Sculpture and Decorative Arts (Kunstkammer) of the Kunsthistorisches Museum Vienna, is very unique in many ways. First of all, it is a rare example of a bigger collection of early modern lampworked glass. Secondly, although it was produced at the glasshouse of the lansburck ducal court, operating between 1570 and 1591, Venetian glassblowers were engaged for limited periods, bringing with them the whole material needed for the production of these outstanding fragile works of art. Considering the conservation state 32 objects could be analyzed with the aim of achieving semi-quantitative results for description and comparison of the glass materials used.

Method and problem statement

In the course of the examination of this collection X-ray fluorescence (XRF) analysis, using the self-constructed PART II (Portable Art XRF) system, was performed. This method was chosen because of its non-destructiveness and the non-portability of the objects. Nevertheless, analysing glass using XRF has to cope with some general problems:
- Absorption of the radiation of light elements (especially Na) in air - although the air path is only about 1 mm using the PART II
- Corrosion of glass-surfases, leading to a depletion of Na (visible on several items of the collection, especially some hues of blue)

Regarding the glass jewellery collection there were additional problems:
- Extremely thin varying thicknesses of the glass parts
- Complex shapes of the objects, complicating the access for analysis

Comparative measurements on fragments not assignable to specific items could be carried out using SEM/EDX (energy dispersive microanalysis in a scanning electron microscope).

Approaches

For the evaluation of the XRF data two software packages were available:
- XPS-PE of Amptek
  - It showed difficulties when Ca was evaluated in the presence of Sn, leading to an extreme overestimation of Ca. As the opacifier in all opaque glasses is PO₄ and SnO₂ this program was not suitable for the analysis of the glass jewellery items.
- WinAxil of Canberra:
  - Here all components could be evaluated semi-quantitatively by using "Compare Mode". The calculation cannot be done in the form of oxides – the conversion has to be done in an additional step using Excel, complicated by the output format of the program (both % and ppm is used). The method of choice:
    - Evaluation showed that, although surfaces without visible corrosion were chosen, a depletion of Na was present.
    - For thin glasses the sum of analysed elements was much less than 100 %.
    - Normalisation is necessary
    - Na leads to the highest uncertainty and is neglected for normalisation

Conclusions

Quantitative analysis of items like the glass jewellery collection of Archduke Ferdinand II is not possible using portable XRF in situ. Nevertheless, to be able to compare the different glass parts and colours a semi-quantitative approach was successfully applied. Glass types could be identified with a higher certainty than with earlier approaches and specific characteristics of different glass parts specified.

Further studies of the results may lead to characteristic groupings of the items, could only be performed on not assignable fragments.

The elaborated method could be tested on the SEM/EDX results of real samples and proved to provide valuable information concerning glass type, colouring elements and comparison of the samples.

Results

The examples shown will focus on colourless and blue glass. Blue glass existed in several different hues. Three of them could be investigated using SEM/EDX and XRF.

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Results in [wt%] obtained with SEM/EDX on fragments – elements that are important for glass and colour identification are indicated in red.

The differently coloured glasses possess characteristic properties. "Blue 1" glass exists either as soda-lime glass or mixed alkali glass, Cu is the colouring element. The "blue 2" glass is mainly cristallo. For "blue 3" cristallo and soda-lime-silica glass can be found. The "green 2" glass is the only potash-lime-silica glass that could be found in all the items.

All analysed colourless glasses are of soda-lime-silica glass with the exception of KK_3041:
- There the colourless glass is mixed alkali. The "blue 1" glass is again mixed alkali and the "green 2" glass is the only potash-lime-silica glass that could be found in all the items.

The whole item is conspicuous concerning its workmanship and has to be reconsidered in the context of the collection.

References

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