

In-situ and time-lapse XRD as tools for atmospheric corrosion research

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Metals are keys to our civilization. They have had a profound influence on the evolution of human societies and they are central to all our technologies. Since time immemorial the noble metal silver has had a huge impact on mankind through its historical use in jewellery, fine utensils, medicine, coinage, photography and scientific instrumentation. It remains vital in jewellery production and art, and continues to find new applications in sensors, semiconductor industry and medicine.

Historical examples of the major uses of silver were in art objects (sacred objects, silver clasps, jewellery), military equipment (armour, helmets, embellishment denoting rank) and aesthetic utility objects (tableware, coins, mirrors, cutlery and vessels). Such objects form a significant part of the European heritage, and are naturally prominent in museum collections. At the same time, the increasing concentration of anthropogenic corrosive gases such as H₂S, SO₂, CO₂, and O₃ mainly present in urban atmospheres presents a serious threat to silver and its alloys, degrading the appearance, functionality and appeal of the artefacts [1]. It is therefore of special interest to clarify the reactions which occur by using in-situ, time-lapse chemical and structural analysis in controlled ambients in order to develop methods and strategies to reduce or even prevent the atmospheric attacks. To ensure protective and secure preservation of these cultural assets in their original state, detailed investigation is required so that all parameters which influence corrosion processes can be taken into account. This is the only way to take appropriate action to preserve these valuable treasures for future generations.

In this study highly sensitive analytical methods (in-situ and time-lapse XRD and IR and Raman Spectroscopy) have been applied over timescales of hours to days to investigate the dynamic chemistry of the atmospheric corrosion behaviour of silver and its alloys while exposed to controlled humidity, ozone and sulphur bearing gases. Besides amorphous and crystalline corrosion species also the reaction mechanisms on the surfaces could be identified [2, 3].

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Keywords: [atmospheric corrosion](#), [silver alloys](#), [time-lapse XRD](#)