APPLICATIONS OF X-RAY DIFFRACTION IN CONSERVATION SCIENCE AND ARCHAEOMETRY

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Analysis performed on works of art and museum objects typically aims at answering two types of questions. First, there are questions related to the materials used to make the objects and to their degradation and ageing. These questions must be answered to ensure the proper conservation of the objects, whether it is preventive or involves intervention on the objects. Second, there are questions related to the date of execution or manufacture, country of origin, or material history of the objects; such studies fall within the field of archaeometry. Although several physical and chemical methods can, and often must, be used to answer both types of questions, X-ray diffraction has always played an important role in the study of works of art and museum objects.

Taking large samples of degradation or corrosion products from artistic and historical objects is often not an issue, since such products will generally be removed as part of a conservation treatment. However, the removal of samples of original material from unique and priceless works of art and museum objects is limited to microscopic amounts. At the Canadian Conservation Institute, we used to perform analysis of very small volumes of powder using a fixed-tube generator and a Gandolfi camera. Samples had to be measured for several hours, typically overnight. In the early 1990s, this system was replaced by a Rigaku rotating anode generator equipped with a conventional θ-2θ goniometer, a mount for a Gandolfi camera, and a microdiffractometer. The microdiffractometer includes a goniometer with a triple-axis sample oscillation mechanism (ω,χ,ϕ), an X,Y,Z stage, and a goniometer head. A built-in 160x microscope allows positioning of the sample in the path of the X-ray beam. Collimators of various apertures are placed in a collimator holder to adjust the size of the X-ray beam. The X-ray detection system includes a curved, position-sensitive, proportional counter (PSPC), a position analysis device, and a multi-channel analyzer. One of the advantages of the microdiffractometer is the great reduction in measurement time for very small amounts of sample, especially when used in conjunction with a rotating anode X-ray generator.

Examples of applications of microdiffractometry and diffractometry in conservation science and archaeometry will be presented to demonstrate the usefulness of these techniques as well as the challenges posed by the analysis of very small samples from works of art and museum objects.