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Chemistry and Art: Ancient textiles and medieval manuscripts examined through chemistry

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ABSTRACT
The socio-historical value of examining ancient textiles and medieval manuscripts is illustrated by specific examples from the author's experience. Materials examined included pre-Columbian Peruvian textiles and Armenian and Byzantine medieval manuscripts, with connections made to present practice in both fields. Synthesis of pigments using recipes taken from medieval artists' manuals pointed to the strong relationship between modern chemistry and the artistic endeavors of the Middle Ages. While chemists always seem to have been more interested in the interface between their discipline and art, as evidenced from the discussion below, the last section of this paper will discuss a recent lively interest on the part of some artists, especially with respect to the chemical changes that take place in a "finished" work of art.

KEYWORDS: pigments, dyes, textiles, manuscripts, analysis, synthesis

RESUMEN
El valor socio-histórico de examinar textiles antiguos y manuscritos medievales se ilustra con ejemplos específicos de la experiencia de la autora. Los materiales examinados incluyen textiles peruanos precolombinos y manuscritos medievales de Armenia y Bizancio, con conexiones hechas a la práctica actual en ambos campos. La síntesis de pigmentos con recetas tomadas de manuales de artistas medievales apunta hacia la fuerte relación entre la química moderna y los esfuerzos artesanales de la Edad Media. De la discusión que se presenta deriva el interés de los químicos por el punto de contacto de la química y el arte; no obstante, en la última sección de este trabajo se discute el reciente interés vívido de parte de algunos artistas sobre los cambios químicos que tienen lugar en una obra de arte terminada.

Palabras clave: pigmentos, tintes, textiles, manuscritos, análisis, síntesis

Figure 1. A diorama depicting a typical ancient Peruvian gravesite. Museo Nacional de Arqueología, Antropología e Historia del Perú, Lima, Perú. Photograph: M. V. Orna.

Introduction

While thinking about how to introduce this paper on chemistry and art, it struck me that there is nothing in art that does not have something to do with chemistry. All art objects are material substances, and as such, are subject to the laws and to the manipulations of chemistry. At the same time, chemistry, in some limited instances, can also be subject to the manipulations of the artist. According to Hill and Simon (2010), art is a mirror of culture and of a culture's values. Using the materials available to them, artists can interpret their experience from a variety of perspectives: historical, socio-historical, symbolic, cultural, behaviorist, communal, environmental, functionalist, and structuralist. Thus, when examining a work of art, a chemist must keep these factors in mind and not concentrate solely on the material substance. Otherwise it would be possible to miss understanding the cultural context out of which the object came, and thus reduce the examination of art to an exercise in analytical chemistry rather than an appreciation of the cultural value of the object in question.

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egar; copper, lime, vinegar, and ammonium chloride (called "sal ammoniac" in the recipes); copper, lime, vinegar, and potassium carbonate (called "oil of tartar" in the recipes). The pigments manufactured from these recipes presented a very complicated chemical profile: some resulted in rather chemically pure products, and others resulted in mixtures that defied analysis. In our laboratory, a compound harvested from a mixture resulting from carrying out a recipe in one of major medieval artists' manuals, the *Mappae Clavicula* (Smith & Hawthorne, 1974), turned out to be identified as calcium copper acetate hexahydrate, an exotic compound whose crystal structure was first determined in 1967 (Langs & Hare, 1967). What we found remarkable in following the chemical pathways of these medieval artists was the degree of sophistication they attained long before the advent of modern chemical theory that would provide a theoretical basis for these syntheses.

For a review of the coordination chemistry of the pigments and dyes cited in this paper, please see reference (Orna *et al.*, 1994).

Modern developments at the interface of chemistry and art

Although artists and chemists alike have always been deeply involved with the use of materials, particularly with respect to their transformation into other forms, artists seem to have neglected, or even shied away from, the application of chemical theory and practice to their artistic endeavors, even though chemistry is, in fact, the scientific discipline most closely related to artistic practice. Spector and Schummer (2003) attribute this marginalization of chemistry to a culturally rooted "chemophobia", but they also give examples of many artists who are willing to experiment with the new materials that chemistry offers, and also with the fact that their work may indeed be a "work in progress" given that chemical reactions within the work may continue over long periods of time after the work of art was presumably "finished".

One artist who has boldly experimented with copper reactions in her works is Cheryl Safren; she has produced works of great beauty without the use of any paint, allowing chemistry to assume center stage. Changing color through reaction, crystallization, fusing, and solidification are a few of the ways chemistry informs her works. "Chemistry", she says "is sometimes the subject of my work, often its inspiration, and always the method or means of its creation. The dynamic process that forms my current work involves copper, chemicals, and extreme heat. Light hits the copper and cascades into a burst of fiery color and then, just as suddenly, tapers off into cool serenity. Mood and thought change as light and color shift rhapsodically. When the light dims or strikes at certain angles the color becomes saturated, majestic, and even reverential. Shifting light on the copper surface and viewer movement are the kinesthetic forces altering perception, allowing us to discover new and interesting things each time we view the work." Figure 9 is a beautiful example of her method.

Figure 9. Safren, Cheryl: *Creation 17*, 2002, 24" ×36", chemistry on copper. Used with permission.

Safren continues: "Many hours of research and experimentation have allowed me to control and manipulate chemicals in order to create these images. While biology and the environment have influenced the subject of these works, it is the chemical interactions that give full expression to the images." Safren (2010) is one example of a developing new world where chemistry is art and art is chemistry!

Concluding remarks

The topic of "Chemistry and Art" is necessarily broad since all art works lend themselves to chemical examination. This paper has outlined several very narrow areas where the two disciplines have interfaced with one another. This interface is continuing to grow as more opportunities arise for dialogue between artists, chemists, curators, and conservationists. It is hoped that all parties, in coming to understand better how a works of art were produced and what their material vulnerability may be, may be better prepared to not only preserve these works for future generations, but also to come to some understanding of the cultures that produced them.

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