PREVENTIVE CARE OF ART ON PAPER FOR ARTISTS: A Technical Guide to Material Selection

The choice of art materials is always a personal one, and the creative process is rarely dictated by preservation concerns (nor should it be). However, for artists in search of materials that remain stable over time, knowing the possibilities and limits of the choices available allows for educated decisions. The following recommendations are designed to give artists awareness of the materials they purchase and use.

1. Paper Choice: Manufacturing and Fiber Type

Three factors determine the quality of artists' paper products on the market: fiber type, manufacturing process, and pH (acidity/alkalinity) of the finished product. These attributes are often related to one another; raw material used during production as well as the manufacturing process generally determine pH of the finished product.

a) Fiber Type

All paper is manufactured from cellulose fibers derived from plants, however, types of plant fiber differ considerably. The strongest papers are made from plant cells high in cellulose; this makes for durable, stable fibers. There are countless fiber types available, but the majority of artists' papers fall into the following categories:

- **Wood pulp**, including ground wood and newsprint paper. Papers made from wood pulp contain lignin—a complex organic polymer that gives wood strength but becomes acidic in paper unless it is removed during manufacture. Acidity can also be a by-product of heavy metals and chemical residues from the bleaching and pulping processes. The majority of papers in everyday use are made from wood pulp, and as a result many of them are acidic.

- **Cotton fibers** produce the majority of rag papers today. Rag paper was originally named for the cotton rags that were processed during paper manufacture. Today's rag paper is generally composed of cotton linters, the shorter fibers left over from cotton thread manufacture; it is chemically and mechanically stable, and as a result is of excellent quality.

- **Other plant-based fibers** are also used (and have been used for centuries) to produce papers of high quality and stability. These include flax, ramie, the bark of various trees (such as mulberry), banana leaf, jute, and straw.

b) Manufacturing Process

The methods used to make paper can affect its stability, as pH and fiber strength are determined through the way raw material is processed from pulp to finished sheet.

- **Handmade** paper is made the same way it has been for centuries, using a vat and screen. It is usually good quality, long-fibered paper.

- **Mold-made** paper is usually produced from quality fibers by a cylinder-mold machine. The majority of fine artists' papers are mold-made.

- **Machine-made** paper has three main types: mechanical pulp, chemical pulp, and machine-made permanent. It is produced from wood fibers by a Fourdrinier machine. Unless the manufacturer indicates otherwise, machine-made paper contains lignin and will degrade quickly.

  Chemical pulp papers are generally of better quality than mechanical pulp papers; they are often marketed as "wood-free" paper. Although they are still made from wood pulp and are not as pure as machine-made permanent paper and mold-made paper, the lignin content is lower. In some cases lignin can be completely removed chemically, leaving an acid-free, high-quality machine-made paper.

  Machine-made permanent paper is produced by a Fourdrinier machine from wood fibers, and the lignin has been removed through chemical processing. Paper meeting the standard for Permanent Paper will have a neutral pH or alkaline reserves, fibers from chemically processed wood pulp or rag fibers, and strong resistance to tearing and folding. It is of excellent quality and is generally used for printing archival records.

  Bleaching and optical brighteners are often used to increase the whiteness of paper which is not naturally bright enough. However, if bleach is left in the fibers, paper can deteriorate. Paper treated with fluorescent bleaching agents in optical brighteners (which make paper appear to be whiter due to their absorption of UV light and re-emission of it as blue light) will eventually turn yellow and darken.

c) Paper pH

The pH of paper selected for stability should always be neutral (7) or alkaline (>7). Paper that is even slightly acidic will have already begun deteriorating by the time pH is measured.

- **Buffered** paper is manufactured with an alkaline reserve, or buffer. This is often (though not always) 3% calcium carbonate. The reserve is beneficial because it helps keep the paper's pH alkaline long after manufacture. However, this alkaline reserve is not indefinite and eventually the sheet may become acidic. The pH at the time of manufacture is generally between 7.5 and 9.5.

- If paper isn't labeled "acid free," or this information needs to be verified, pH pens or pH strips are an inexpensive way of testing this in the studio or at home.

- Note: paper that will come in direct contact with some photographic materials (color prints, albumen prints, and cyanotypes) should not be buffered, as these materials are sensitive to alkalinity.

2. Understanding Manufacturers' Terms and What They Mean (or Don't Mean)

When selecting paper for quality and stability, it can be very easy to get confused by the terminology used seemingly at random by manufacturers. Knowing what these terms actually mean will help to avoid confusion while choosing paper.

- **Acid-free** refers to papers that the manufacturer has determined to have a neutral pH (7) or an alkaline pH (>7). Acid-free paper products can in theory be composed of almost any fiber—from cotton rag to wood pulp, and many other things in between. However, due to the acidic nature of wood pulp, this means that the

finished sheet has been buffered with an alkaline reserve (usually calcium carbonate) and/or has had the lignin content chemically removed or diminished. The term acid-free connotes material that is designed to remain stable over time, but in reality, the acid-free label is only guaranteed at the time of manufacture. Buffering likewise does not guarantee that the paper won't become acidic as the alkaline reserve becomes depleted. For this reason, it is helpful to know which plant material the paper is composed of; certain materials and paper processes are inherently more stable than others (i.e. mold-made cotton papers, handmade mulberry papers).

- **Alpha-cellulose** refers to the class of cellulose that has the highest degree of polymerization and is the most stable. Papers with a high alpha-cellulose content include cotton, ramie, flax, and kozo (mulberry bark). Wood pulp can be used to produce alpha-cellulose fibers through chemical processing, as with machine-made permanent papers.

- **Archival** or **archival-quality** are terms that manufacturers originally used to designate a material that was suitable for long-term storage. Over time, however, these terms have been applied so indiscriminately that they do not necessarily mean anything at all—don't be fooled by seeing them, unless the manufacturer has also included other information to identify pH and fiber content. A claim of "archival" must be supported by material content and pH information (i.e. 100% cotton or acid-free rag paper).

- **Conservation-grade** originally referred to "acid-free" paper that was wood pulp-based and buffered. While it is better quality than some types of paper, it is not suitable for conservation or long-term storage as the alkaline reserve may be depleted over time. Be aware that this term may also be used indiscriminately.

- **Permanent Paper** indicates that the paper meets standards for paper manufacturing, such as US ANSI/NISO Z39.48-1992 or ISO 9706. These standards establish criteria for manufacturers of paper and for the production of coated and uncoated papers that will last for several hundred years. Standards cover pH value, tear resistance, alkaline reserve, and lignin threshold. Paper meeting the standard for permanent paper will have an infinity symbol identification mark. Permanent paper is usually used for documents and printed material. Archival Permanent Paper is designated by ISO 11108 and is designed to be an especially durable, stable paper for "publications of high legal, historical, or significant value."

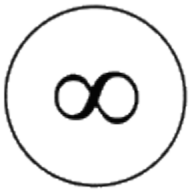

Figure 1. Example of the Permanent Paper symbol from Hanus 1996[1].

- **Rag paper** is made of long fibers, usually cotton (but can also be composed of other materials). In general, it is strong, long-lasting, and of a superior quality to other papers, particularly for use in fine art. Most rag papers will be labeled "100% Cotton" or "100% Cotton Rag."

[1] Hanus, Jozef. Some Properties of Permanent Paper Made in Slovakia. *Alkaline Paper Advocate* 9 (1): 1996.

3. Lightfastness of Media

In an attempt to bring order to the wide variety of information provided by manufacturers, ASTM International (formerly the American Society of Testing and Materials) formed a subcommittee on artists' materials to independently test pigments for lightfastness, or resistance to change due to light exposure. Lightfastness ratings are as follows:

ASTM Lightfastness Ratings

Lightfastness I	Excellent Lightfastness
Lightfastness II	Very Good Lightfastness
Lightfastness III	Fair Lightfastness
Lightfastness IV	Poor Lightfastness
Lightfastness V	Very Poor Lightfastness

An increasing number of art material manufacturers are publishing the results of lightfastness testing on their websites, which can be excellent resources.

It is important to note that the lightfastness of a particular pigment can change depending upon the vehicle. For example, Vermilion (a vibrant red) has a lightfastness rating of I (Excellent) in oils and acrylics; however, in a watercolor vehicle it has a rating of III (not lightfast). For this reason, it is important to check the lightfastness rating for a specific manufacturer and medium whenever possible.

Certain manufacturers may refer to "permanence" instead of lightfastness, or use other proprietary terminology, symbols, or reference scales. These rankings should not be assumed to correlate with ASTM standards unless specifically stated.

Performing a Lightfastness Test at Home or in the Studio

Not all media and brands have easily accessible lightfastness ratings. As standards for rating the lightfastness of media become defined for a wider range of art materials, more information is made available.

However, there is a way to test the art materials you may already have, or confirm the results a manufacturer has published. Conducting your own lightfastness test is a good way to verify manufacturer information. By nature, testing the lightfastness of materials in the studio or at home will not provide the degree of accuracy that a lab would, but it is still worthwhile. There are two tests that can be done at home: a simple lightfastness test and a Blue Wool Standard lightfastness test.

In a simple lightfastness test, samples of a chosen medium are prepared and then exposed to natural daylight for several months, while a control sample is kept covered to compare change. A more standardized method uses Blue Wool Standard Textile Fading Cards to extrapolate the lightfastness of a chosen media sample. In this test, a set of dyed blue wool samples with known properties are exposed to light alongside the media being evaluated for lightfastness. Each area of the blue wool scale has a different rating; as soon as a visible change occurs in the exposed area of a blue wool sample, the light exposure has reached that level. Once the media being tested begins to show visible changes, it is compared to the corresponding area of visible change on the scale and is given a lightfastness rating.

ASTM standard D5398, "Standard Practice for Visual Evaluation of the Lightfastness of Art Materials by the User," uses Blue Wool Textile Fading Cards and is available for purchase at www.astm.org/Standards/D5398.htm. Detailed descriptions of procedures for both tests can also be found in *The Painter's Handbook* (Gottsegen) and at www.handprint.com/HP/WCL/pigmt9.html.

4. A Guide to Selecting Stable Media

Currently, art materials manufacturers are not legally required to comply with ASTM standards; compliance is purely voluntary. However, it is easy to distinguish compliant manufacturers, as the label for compliant products must list several things that help to identify the quality of the material. Most artist material standards describe labeling, composition, physical properties, performance requirements, and methods for testing the media, as well as pigments, vehicles, and additives.

Acrylic, Alkyd, and Oil Paints

Specifications for artist's oil, resin-oil, and alkyd paints are covered under ASTM D4302, and acrylic paints are covered under ASTM D5098. Labels for paint products conforming to these standards must include the following information:

1. Identification of the pigment(s) contained in the paint—specified by common name, color index name, and any additional terms used to identify the colorant(s). For a paint composed of multiple pigments to get a lightfastness rating of I, for example, all of the pigments used in the manufacture of the paint must individually receive a rating of I.

2. Identification of the vehicle (i.e. the vegetable source and refinement for an oil-based paint).

3. Lightfastness rating. Only pigments that appear in a table of suitable pigments can be used in paints that conform to ASTM specifications.

4. Volume contents of the container.

5. A statement certifying that the contents conform to the labeling requirements of the Federal Hazardous Substances Act, its amendment for chronic hazards, and the Labeling of Hazardous Art Materials Act.

6. A statement certifying that the contents conform to the standard.

7. Manufacturer name and address, or the importer's name and address, along with the country of origin.

Many paint manufacturers carry ranges of varying quality, i.e. student or value ranges as well as best quality ranges. This is often expressed in the pigment-to-binder ratio, or the way the pigments are dispersed. Using the higher-quality ranges whenever possible will help to prevent shifts in the medium as it ages, although student or value ranges may also be suitable depending on the paint chosen.

The Painter's Handbook (2006) by Mark David Gottsegen has extensive notes on the lightfastness ratings of pigments in a variety of vehicles and is an invaluable resource for pigment information.

Charcoal and Graphite
These materials are carbon based and in theory very stable. Inconsistencies in the binder or proprietary additives can affect the purity of the finished product, however. For this reason, it is best to check the manufacturer's lightfastness ratings or perform a Blue Wool Test yourself.

Pastel
Pastel lightfastness is dependent upon the pigment(s) used in their formulation, as there is very little binder. The biggest threat to works created with pastel is the friable nature of the medium (a tendency to be powdery or crumbly and therefore easily smeared or dislodged from the paper surface). ASTM standards for pastels are in process; in the meantime, an increasing number of manufacturers list lightfastness information on their websites.

Watercolor
Watercolor paints are, in general, more susceptible to deterioration from light than other paint mediums made with the same pigments. This is mostly due to differences in the binder; where oil and acrylic paints receive a small amount of protection from the viscosity of their binders, watercolors do not. In addition, the thin layers in which watercolors are usually applied makes them especially vulnerable to light damage.

Colored Pencils
Colored pencils have been given their own standard, ASTM D6901, which provides a lightfastness test method and quality labeling information. Not all manufacturers adhere to this standard, but those that do will post this information on their websites; some brands have special ranges that are designed to be lightfast. If unsure, Blue Wool Tests can be carried out at home or in the studio.

Technical and Fountain Pen Ink
Most commercially available ballpoint and drawing pens are dye-based and have poor lightfastness. However, several manufacturers produce pigment-based ink pens, which have a superior permanence and have been given appropriate lightfastness ratings. These come in a range of colors and tip widths.

Liquid Ink
Traditional India, or Chinese, ink is composed of a carbon-based black pigment mixed with water and a binding agent such as gelatin or shellac. Colored or black liquid ink can be made with dyes or pigments. Ink made with pigments tends to be more lightfast and indelible than ink made with dyes.

Felt-tip Pens and Markers
The majority of felt-tip pens and markers fall under two categories: water-based and solvent-based. Most dye-based ink is inherently acidic and will fade when exposed to light. If felt-tip pens and markers are chosen for work, avoiding prolonged exposure to light is necessary to extend the life of the object. Dye-based markers labeled "permanent" are not lightfast—this designation only means that the ink is indelible in water.

"Archival" markers and pens are acid-free and contain pigments rather than dyes. They make a good alternative to dye-based pens and markers; however, they still have limited lightfastness. The Winsor & Newton Pigment Marker has recently come on the market and claims to offer up to 100 years of lightfastness.

Dye-based Inkjet Prints
Inkjet dyes are primarily suspended in water, with a solvent (glycol or glycerin) added to control drying time and thickness. Proprietary additives are also included to control ink-drop formation, pH level, lightfastness, and other qualities. Inkjet dyes are extremely prone to fading in light, are sensitive to water and humidity, and are vulnerable to environmental gases.

Pigment-based Inkjet Prints
In combination with the right paper, pigment-based inkjet prints can last for years. Permanence tests on various combinations of ink and dye on specific printing papers and substrates are available on Wilhelm Research's website, www.wilhelm-research.com.

5. Compatibility Between Paper and Media

Long-term stability can also be affected by the compatibility between the media and substrate—paper type, ground media applied (if any), and the method of application all affect the way a work ages. Paper manufacturers often indicate which of their paper products are compatible with various media. A thorough guide to use for matching media to paper is *Which Paper? A Guide to Choosing and Using Fine Papers for Artists, Craftspeople, and Designers* (1991) by Silvie Turner.

Resources for Materials

Conservation Support Systems
PO Box 91746
Santa Barbara, CA 93190-1746
(800) 482-6299
www.conservationsupportsystems.com

Talas
330 Morgan Avenue
Brooklyn, NY 11211
(212) 219-0770
www.talasonline.com

Dick Blick Art Materials
P.O. Box 1267
Galesburg, IL 61402-1267
(800) 828-4548
www.dickblick.com

University Products
517 Main Street, PO Box 101
Holyoke, MA 01040
(800) 628-1912
www.universityproducts.com

Gaylord Bros
PO Box 4901
Syracuse, NY 13221
(800) 448-6160
www.gaylord.com

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Wilhelm Imaging Research website: www.wilhelm-research.com.

Winsor & Newton Composition and Permanence Tables: www.winsornewton.com/na/discover/resources/composition-permanence.