SAFEGUARDING COMIC BOOKS

Preservation Challenges and Practical Solutions Informed by Conservation Science

Abstract

Comic book collections are treasured for their personal and cultural significance as well as for their financial value, but they face risks from environmental factors, chemical damage, and physical deterioration. This white paper explores these preservation challenges and proposes a solution combining Mylar sleeves and different types of archival paper - used in museums and libraries worldwide. We analyze the benefits of Mylar over common plastic sleeves in terms of durability, protection, and cost-effectiveness. The document provides practical recommendations and a comprehensive examination of various perils, impacts, and mitigation strategies. By raising awareness and offering actionable solutions, this paper aims to help collectors preserve both the sentimental and financial value of their collections.

Dr. Jasmin Sahbegovic,
Managing Director at Tvartcomics LLC, Switzerland
Jasmin.sahbegovic@tvartcomics.com

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Executive Summary

Comic Books Possess Sentimental and Financial Value

Comic book collections often represent more than just printed material; they embody cherished memories, personal milestones, and in many cases, significant financial investments. This white paper delves into the multifaceted nature of comic book preservation, emphasizing both the sentimental and financial stakes involved. As comic books gain value in the marketplace, ensuring their long-term preservation becomes crucial, not only to protect their physical condition but also to maintain their value and personal significance.

Comic Books Are Exposed to Multiple Preservation Risks

Comic books are at risk of several negative impacts that can significantly affect their condition and value:

Brittleness and Yellowing: Over time, paper can become brittle and discolored due to chemical degradation. This makes the pages fragile and more prone to tearing.

Warping and Cracking: Fluctuating temperature and humidity levels can cause the paper to warp, curl, or crack, compromising the structural integrity of the comic.

Color Fading: Prolonged exposure to light can lead to the loss of vibrant colors and details, diminishing the visual appeal and collectible value of the comic.

Staining and Spots: Mold growth and pollutants can cause unsightly stains and brown spots, known as foxing, which affect both appearance and value.

Infestation Damage: Insects and fungi can cause physical damage and further deterioration, leading to additional loss of material and integrity.

Odor: A presence of odor, whether pleasant (e.g., almond, vanilla) or unpleasant (e.g., sour) often indicates ongoing chemical breakdown or mold issues, signaling potential underlying damage.[1]

Generally, comic book collectors use transparent plastic bags to protect their precious items at home. Plastic bags can actually offer protection from improper handling, physical damage, cross-contamination, pests, which are frequent problems one can face in a home, not protected, environment, but can expose the comic books to other risks.

Addressing these risks through proper storage and care is essential to preserving the condition and value of comic books.

[1] Note that the presence of a seemingly pleasant odor can also indicate the ongoing degradation of cellulose in paper. One such marker of hydrolytic degradation is the formation of **furfural**, a volatile organic compound. Furfural emits a characteristic "bread-like" or almond scent, which is also the same compound released during the baking process (Bembibre, 2017).

To address these risks, we provide practical guidance and propose a comprehensive preservation solution that combines the use of Mylar comic bags and different types of archival paper. These materials are recognized by professional conservationists for their effectiveness in safeguarding delicate items. Mylar comic book bags offer superior protection against physical damage, pests, and contaminants, , while archival paper helps manage humidity and absorb harmful gases to prevent books from acidification, degradation and odor buildup. Also, Mylar has a larger chemical stability, compared to other plastics, minimizing possible volatile degradation by-products. Together, these solutions create a robust defense against the perils faced by comic books.

Conclusions

- **Importance of Preservation** Effective preservation techniques are essential for maintaining the value and condition of comic book collections. Both sentimental and financial aspects are at stake.
- **Proven Solutions** Using Magicover Mylar comic sleeves and archival paper represents a best practice approach for comic book preservation, backed by their use in professional settings like museums and libraries.
- **Awareness and Education** Many collectors may not fully understand the risks associated with comic book preservation or the most effective mitigation strategies. Increased awareness is necessary for effective preservation.

Recommendations

- **Adopt High-Quality Materials to Preserve Comics**

  Utilize Magicover Mylar comic book sleeves and ZEO archival paper to protect comic books from chemical degradation, physical damage and environmental factors. Investing in these high-quality materials ensures the long-term preservation of your collection.

- **Control Environmental Conditions and Implement Proper Storage Practices**

  Maintain stable temperature and humidity levels. Use UV filters to protect against light exposure and air purifiers to reduce harmful gases. Store comics in Magicover Mylar comic bags, use archival backing boards or archival boxes to provide structural support and prevent external pollutants from affecting them. Handle comics with care to avoid physical damage.

- **Periodic Maintenance**

  Conduct regular inspections to identify and address potential issues early. Consult professional conservators for expert advice and interventions when needed, especially for severe or complex preservation challenges.

By following these recommendations, comic book collectors can better protect their collections, preserving both their emotional and financial value for years to come and future generations. In summary, this white paper aims to raise awareness among comic book collectors about the critical risks to their collections and the best practices for mitigating these risks.

Introduction

For many comic book collectors, their collections represent far more than just ink and paper bound together. These treasured items often carry deep sentimental value, evoking memories of childhood heroes, family traditions, or the joy of discovering a new story. Each comic book can be a personal artifact tied to a unique moment in time, making preservation not just about maintaining physical condition but also about safeguarding fond memories. The emotional connection to a comic book collection elevates its worth, making long-term preservation essential for protecting both nostalgia and personal history.

In addition to their sentimental value, comic books have also become significant investment opportunities. Rare and sought-after issues can appreciate dramatically in value, sometimes fetching substantial prices in the marketplace. However, this potential for financial gain can be compromised if the comics are not properly cared for. Environmental risks such as humidity, temperature fluctuations, and pollutants, along with handling mistakes, can degrade the quality of a collection, reducing both its emotional and monetary value.

This white paper explores the risks that threaten comic book preservation - ranging from chemical and environmental hazards to physical damage - and will present a recommended solution that combines the protective properties of Magicover Mylar comic book bags with the added security of archival paper. This strategy provides a comprehensive approach to preserving both the sentimental and financial value of comic book collections for the long term.

Mylar polyester film type D or equivalent (Library of Congress Preservation Office, 2009), (Library of Congress Preservation Office, Research Services, 1980) sleeves and archival paper[2] (Baty, 2010), (International Federation of Library Associations and Institutions (IFLA) , 1998) are professional and tested solutions widely used in museums, archives, and libraries around the world for the preservation of valuable and delicate documents which are frequently handled or are particularly fragile. See more in (Heritage Council Collections, 1998). These proven methods are employed to safeguard documents, artworks, and other irreplaceable items from environmental damage and physical deterioration. In the realm of comic book collecting, adopting these standards is crucial for maintaining the integrity of collections. Despite their widespread acceptance in the field of preservation, many collectors may still lack awareness of the specific risks their collections face and the most effective ways to address them. This white paper aims to both raise awareness about these risks and provide actionable solutions to enhance the preservation efforts of comic book enthusiasts. By highlighting the importance of proper storage and handling techniques, we hope to foster a greater understanding of how to protect these invaluable pieces of personal and cultural history.

This white paper is designed to provide a thorough overview of comic book preservation, offering practical advice tailored for both casual and dedicated comic book collectors. It begins with ***Introduction*** that sets the stage for understanding the importance of preserving comic

[2] Throughout this document, *archival paper* or *archival quality paper* refers to acid-free, lignin-free, buffered (typically with calcium carbonate 2-3%) paper with alkaline pH, ranging between 7 and 9). The archival paper is typically used for interleaving the pages of comics, books and other paper materials to prevent released acidic and other harmful gasses from accelerating degradation process of preserved documents.

book collections. The following section, ***Comic Book Degradation and Causes*****,** delves into the various threats that can impact comic books, from environmental hazards to physical damage. This is followed by ***Guidelines for Preserving Comic Book Integrity,*** which offers a comprehensive overview of practical solutions to counteract these threats and maintain the condition of the collection. The next section ***Preferred Solution for Archival Preservation*** explains why a combined usage of Magicover Mylar comic book sleeves and ZEO / MicroChamber paper offers cost-effective solution for optimal, long-term preservation. We then briefly tackle ***Other Archival Products and Treatments*** and conclude with ***References***.

By following the guidance provided in this white paper, comic book collectors can implement effective preservation strategies that protect their collections from various risks, ensuring they remain in the best possible condition for years to come.

Comic Book Degradation and Causes

Comic books, like any paper-based medium, are subject to the inevitable effects of aging, which can significantly impact their condition and value over time. Paper aging refers to the gradual degradation of paper over time due to chemical, physical, and environmental factors. As paper ages, it undergoes several changes that affect its appearance, texture, and structural integrity. These changes are influenced by factors such as the composition of the paper, the conditions it is stored in, and the interactions it has with its surroundings. Key factors that accelerate this process include light, temperature, humidity, and pollutants. Exposure to light, particularly ultraviolet (UV) rays, breaks down cellulose fibers in paper, causing yellowing, brittleness, and fading of inks. Fluctuations in humidity further weaken the structural integrity of the paper - excess moisture promotes mold growth and warping, while low humidity leads to brittleness. Pollutants such as airborne particulates, sulfur dioxide, and ozone chemically react with paper and inks, resulting in discoloration and degradation. Collectors, historians, and enthusiasts must understand and mitigate these risks by ensuring proper storage conditions, including controlled lighting, stable humidity, and pollutant-free environments, to preserve the longevity and value of these cherished items.

Key Factors Contributing to Comic Book and Paper Aging:

- **Improper Storage and Mechanical Stress**: Stacking too many comics on top of each other, wrong-sized box (a box too small can cause folding or a box too big can cause damage through shifting in the box). In general, handling, folding, and bending paper can cause mechanical wear and tear. Over time, repeated stress can lead to tears, creases, and general weakening of the paper structure, further accelerating the deterioration process.
- **Environmental Conditions and Pollutants as Chemical Degradation Catalysts:**

  Environmental conditions such as temperature, humidity, UV light exposure and airborne pollutants play a significant role in the aging of paper. For example, high humidity can lead to mold growth and encourage chemical reactions (see paragraph A*cid Hydrolysis and Oxidation*) that degrade paper, while fluctuations in temperature can cause expansion and contraction, leading to physical damage like warping or cracking. Additionally, the appearance of brown or reddish spots (the so-called *foxing*) can develop due to humidity combined with fungal activity or reactions between metal impurities and moisture[3]. Airborne pollutants, such as sulfur dioxide and nitrogen oxides stemming from different indoor and outdoor sources ranging from cooking, smoking, off-gassing from furniture, wall-paint and electronic devices to burned fuel and vehicle exhaust, can react with the components of paper, leading to chemical degradation.

[3] In the context of foxing, **metal impurities** refer to tiny traces of metal ions, such as iron or copper ions, that can be present in the paper from the manufacturing process. These metal ions can come from the raw materials used to make the paper (like water, pulp, or chemicals) or from equipment and tools involved in the production process. The metal impurities can act as catalysts in the reaction of cellulose degradation, leading to yellow or brown by-products, accelerating the degradation of the cellulose fibers in the paper and contributing to the discoloration. Additionally, these metal species can interact with fungi that thrive in humid conditions, further intensifying the development of foxing.
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Dust and dirt can also accumulate on paper surfaces, causing abrasion and discoloration, further contributing to the paper's worn appearance.

- **Acid Hydrolysis and Oxidation**: Many older papers, especially those made from wood pulp, contain lignin and other acidic compounds. These inherent compounds, or acids absorbed from the environment, lower the pH of the paper, creating a favorable environment for acid hydrolysis. Hydrolysis is the breakdown of organic compounds (in this case cellulose fibers) through interaction with water and is catalyzed by these acids and exacerbated by extreme humidity and temperature. Over time, hydrolysis weakens the cellulose chains, causing the paper to become brittle and discolored.

  Oxidation is defined as a chemical reaction involving the loss of electrons from an atom: it plays a significant role in paper degradation process as well. When cellulose in paper oxidizes, it produces carboxylic acids, which further acidify the paper and accelerate hydrolysis. Exposure to unfavorable environmental conditions (outlined in the previous paragraph) can speed up oxidation. Oxidative reactions themselves break down cellulose chains, making the fibers more susceptible to water and acid attack. This combination of acidification and oxidative damage degrades the paper's overall structure, reducing its strength and flexibility, and making it more fragile and susceptible to further deterioration.

- **Biological Factors**:
  - **Mold and mildew (temperature, humidity,** dust **)**
  - **Pests (insects, rodents) directly or indirectly [4] damage through their leavings; warm and dim environment**
- Insects, rodents, and microorganisms like fungi can also contribute to the deterioration of paper by feeding on or infesting it. Mold growth, especially in humid conditions, can cause staining and weaken paper fibers, while insects can create holes and tears.
- **Incidental (disasters, incorrect long-term storage, vandalism)**
- **Inherent factors –** physical properties and composition of the paper and the inks (which are very often acidic and contain metals) that in combination with the above factors can lead to accelerated degradation[5]

Signs of Comic Book and Paper Aging:

- **Yellowing or Browning**: One of the most common signs, often due to oxidation and acid degradation.
- **Brittleness**: As paper ages, it can become brittle and prone to cracking or tearing.

[4] Powder / dust particles transport spores and little insects like acarus which attract other larger insects.
[5] E.g., rosin, a common glue used for paper sizing, and alum, a mordant, are acid and contribute to paper hydrolysis. Lignin, not acidic by itself, can however lead to acidic by-products during the steps of lignin removal from the cellulose pulp. The mechanical pulp paper has an important lignin content. The lignin is oxidized by exposure to oxygen and light. This means more degradation on such paper

- **Foxing**: The appearance of brown or reddish spots, often caused by humidity, fungal activity, or metal impurities in the paper.
- **Color Fading**: Loss of intensity in the inks and pigments, particularly from prolonged exposure to light, reducing the visual impact of printed images and text.
- **Staining**: Discoloration caused by environmental pollutants, biological activity, or even reactions with certain inks and adhesives.
- **Warping or Curling**: Changes in humidity can cause paper to expand or contract unevenly, leading to warping.
- **Odor**: a musty, stale or often even pleasant almond-like smell. As paper ages, may develop a distinctive odor, a common sign of degradation, which occurs as the paper and inks break down over time due to various environmental factors. The source of this odor is typically the breakdown of chemical compounds within the paper or the growth of mold and microorganisms. More specifically, these odors are caused by volatile organic compounds (VOCs), small molecules that are released when larger, heavier organic molecules in the paper start to break down.

Preservation:

To slow down the aging process, archival techniques are used, such as storing paper in acid-free environments, controlling temperature and humidity, and limiting exposure to light. For valuable documents, treatments like deacidification and enclosure in protective bags or covers may be applied. These preservation methods help to mitigate the effects of aging, including foxing and color fading, ensuring that paper-based materials remain in good condition for future generations.

Table 1: Key Perils, Risks and Associated Drivers

Key Perils	Associated Risks	Potential Drivers
Acid Hydrolysis	Brittleness, yellowing, eventual crumbling of pages	- Older comic books printed on acidic paper
		- Storage in fluctuating or high humidity and temperature
		- Lack of acid-free protective materials (e.g., backing boards, boxes)
		- Use of poor, non-archival storage materials, allowing VOC release
Oxidation	Discoloration, yellowing, weakening of paper fibers, fading	- Prolonged exposure to sunlight or artificial UV lighting
		- Inadequate storage (e.g., open or poorly shielded areas)
		- Use of non-archival storage materials that allow light penetration
Environmental Conditions	Warping, curling, cracking, mold growth, foxing	- High or fluctuating humidity levels (e.g., storing in basements or attics)
		- Extreme temperatures or rapid temperature changes
		- Storage in damp areas or near leaks
		- Improper ventilation in storage areas
Pollutants	Staining, abrasion, discoloration, chemical degradation	- Exposure to dust, dirt, smoke, and airborne chemicals
		- Storage near sources of pollution (e.g., windows, garages)
		- Lack of protective enclosures (e.g., archival bags and boxes)
Mechanical Stress	Tears, creases, loss of structural integrity, damaged covers	- Frequent handling
		- Improper shelving or stacking of comics
		- Storing comics without support (e.g., outside thicker sleeves, no backing boards etc.)
		- Using tight or non-archival bags that cause stress on the paper
Biological Factors	Physical damage from insects, rodents, mold, and fungi	- Storage in pest-prone areas (e.g., basements, attics, garages)
		- Lack of regular cleaning or monitoring of storage
		- Exposure to humid or damp conditions promoting mold growth
		- Storing comics with organic materials that attract pests (e.g., cardboard, untreated wood)

Guidelines for Preserving Comic Book Integrity

The following breakdown lists recommended actions for preserving comic books, highlighting how each action addresses multiple risks.

General Preservation Principles Control Environmental Conditions

Maintain stable temperature and relative humidity and limit exposure to light in order to prevent paper yellowing, brittleness, and material degradation.

- **Temperature Control**

  Recommendation: Maintain a **consistent** temperature within **18-21°C**[6].

  Note that while colder temperatures (however above **10°C**) are still tolerable and chemically may be considered even preferable[7], high temperatures are less so, especially combined with high or low relative humidity. Heat and high humidity can cause the comics to mold, whereas heat coupled with low humidity may lead to desiccation and embrittlement. Consistency in temperature is key, as fluctuations - particularly extreme or frequent ones - can cause expansion and contraction of the paper, leading to brittleness and warping. On the other hand, a controlled gradual temperature shifts in conjunction with adequate humidity levels (18°C to 16°C and from 50% to 40% relative humidity) can however substantially increase the longevity of a comic or paper collection. (Duran-Casablancas, 2021)

  Useful tips:

  - Avoid storing comics near heat sources like radiators or electronics.
  - Avoid storing comics near windows or external walls exposed to temperature changes.
  - Use air conditioning to maintain constant temperature.

- **Humidity Control**

[6] https://guides.loc.gov/preserving-your-books/storing.
https://www.bar.admin.ch/bar/en/home/archiving/analogue-documents.html
https://www.staatsarchiv.sta.be.ch/de/start/fuer-behoerden/konservierung-und-restaurierung.html
https://www.nb.admin.ch/snl/en/home/information-professionals/preservation/prevention.html
https://www.ifla.org/files/assets/pac/ipi/ipi1-en.pdf

[7] Note while the temperature range 18-21°, considered acceptable for wellness of human beings is also adequate for comics storage, lower temperatures are preferable in view of slowing down undesired chemical reactions involved both in chemical degradation and biodeterioration of comic books and paper materials. However, while low temperatures are less of a concern than high temperatures and humidity, they can still pose risks to comic book preservation. In particular, extremely low temperatures can make paper more brittle and prone to cracking or breaking when handled. This is especially true if the paper has not been properly conditioned or is already fragile. Low temperatures can also affect the ink and adhesive used in comics. Inks might become less flexible, and adhesives could lose their effectiveness or become brittle. Cold together with high humidity and poor air circulation will lead to dampness and eventually mold growth. Hence, prolonged exposure to very low temperatures can compromise the structural integrity of comic book covers and binding.

Recommendation: Maintain a **consistent** relative humidity within **30-55%**[8]

Organic matter is hygroscopic, this means that paper gains and loses water with increases and decreases in relative humidity. Consequently, materials expand and contract as moisture levels rise and fall. Note however, that there is no one ideal humidity level for all types of library material – there are only values and ranges that minimize specific types of change in materials and objects. A humidity and temperature that are acceptable for one object may be less so for another. A range of 30-55% relative humidity is assessed as acceptable and achievable in most cases, balancing several aspects, including levels of moisture high enough to maintain flexibility and a moisture low enough to slow deterioration of materials and control insects and mold.

Similar as with temperature, maintaining consistent relative humidity is key. A rapid rise in the relative humidity may lead to condensation and possibly resulting in mold and other problems excess moisture causes. Fluctuations of temperature and relative humidity affect the dimensions and mechanical properties of organic materials and can lead to damage if they occur over a short period of time. Visible damage can take the form of flaking inks, warped covers on books. (International Federation of Library Associations and Institutions (IFLA) , 1998).

There is scientific evidence to suggest that paper will retain its chemical stability and physical appearance for longer at a constant storage temperature below 10 °C and relative humidity within the range of 30-40%. However, while a relative humidity below 40% may reduce chemical changes it can also make materials shrink, crack, and become brittle over time. Note also, while the paper materials may benefit from being kept at a low relative humidity, non-paper-based covers of some comic books (e.g., special comic editions with leather binding) will suffer. Leather and vellum materials need at least 50% humidity if they are to continue to operate mechanically. (International Federation of Library Associations and Institutions (IFLA) , 1998).

While relative humidity of 55–65% helps keep materials flexible and minimize mechanical damage, such humidity levels in poor ventilated spaces can result in mold, mildew, and warping. Moreover, a relative humidity above 65% can cause adhesives in comics to soften, weakening their bond. For humidity above 70%, the risk of mold growth increases significantly, even at low temperatures. In poorly ventilated areas, humidity should not exceed 60%, and in well-ventilated spaces, it should be kept below 65% to prevent mold. (International Federation of Library Associations and Institutions (IFLA) , 1998).

Useful tips:

- Regularly monitor humidity levels with a hygrometer.

[8] https://guides.loc.gov/preserving-your-books/storing
https://www.bar.admin.ch/bar/en/home/archiving/analogue-documents.html
https://www.ifla.org/files/assets/pac/ipi/ipi1-en.pdf

- Avoid storing comics in basement and attic or rooms exposed to excess or changes in humidity (e.g., rooms neighboring kitchen, bathroom). [9]
- Do not lean comics directly against the walls, i.e., keep the comics 1 cm away from the wall. This way the insulating property of air should reduce the risk of humidity from the wall.
- Store comics on shelves, raised off the ground.

- **UV Exposure Control**

  Recommendation: Keep comics **away from direct sunlight and fluorescent lighting** Note also that even with UV-protective covers, overexposure to light can still result in fading over time. Avoid leaving comics in light for extended periods.

  UV-Protective Covers: Use UV-blocking Mylar sleeves[10] or archival storage boxes.

- **Air Quality and Gaseous Pollutants**

  Air Purifiers: Use HEPA air purifiers with activated carbon filters to reduce airborne pollutants. Regularly replace or clean the air purifier filters. Clogged filters can circulate pollutants rather than remove them.

  Ventilation: Ensure proper ventilation to prevent the buildup of harmful gases. However be cautious of dust and other contaminants that may enter from outdoor air such as particulates from burned fuels, as these can introduce new risks to comic book preservation.

Mitigate Physical Damage – Storage, Handling and Reparation

- **Handling Techniques**: Always handle comics with clean, dry hands to avoid transferring oils, dirt, or moisture to the pages.
- **Page Turning**: When reading or examining comics, turn pages gently by the edges to avoid creasing or tearing. Avoid pressing down on the comic when reading, as this can cause damage to the spine and pages.
- **Support During Handling**: Use a flat surface to support the comic while viewing or reading. This prevents unnecessary bending or folding that could result in creases or damage.
- **Cleaning Techniques**: periodic dust removing is an important routine to protect artifact as dust contain pollutants of various types. Either use a soft brush (e.g., squirrel hair brush) to gently wipe dust or particles or air blower to gently remove them without scratching or damaging the pages. Never use water or liquid cleaners on the comic's surface.

[9] Even using (de)humidifiers or silica gel packs in such an unbalanced environment may be damaging if not strictly controlled. E.g., overusing dehumidification can lead to excessively dry conditions, causing comics to become brittle or bad maintenance of the dehumidifier may lead to mold growth within the device itself.

[10] https://stenbacka.fi/wp-content/uploads/sites/3/2016/07/mylar_a_uv_ominaisuudet.pdf

- **Reparation:** For a long-lasting non-invasive repair, we recommend Washi / Japanese paper[11]. This paper is both strong and thin, allowing it to blend seamlessly with the comic's original paper without compromising its structural integrity. Professional conservators often use Japanese paper to mend tears and stabilize damaged areas because it provides a more discreet and reversible repair. In particular, the paste generally used to adhere washi to book pages can be typically removed simply and cleanly by adding moisture, thereby returning the document to its pre-repair state if necessary. However, completing training before using washi for conservation of paper materials is recommended.

  Alternatively, one may choose to repair minor tears with acid-free tape or other archival repair materials. Note however, while using these materials can help prevent further damage, they are likely irreversible and can also impact the comic book's value and aesthetics. In particular, the presence of visible repair materials may detract from the overall appearance, and improper use of "patches" could alter the comic's original look or feel. The extent of this impact depends on the quality of the repair. For more extensive damage, consult a professional conservator.

These manual handling practices significantly reduce the risk of both physical and chemical damage, helping preserve the condition of your comic collection.

Periodic Inspections for Cross-Contamination, Damage and Maintenance

Regular checks are essential for maintaining the condition of comic collections. This is especially important in case the comics are not protected by archival-grade products such as Magicover Mylar comic sleeves and buffered boxes, boards and paper.

Inspect for signs of pests such as insects or rodents. Check for signs of (cross-)contamination such as odors, discoloration or residue and remove contaminated items from the collection. Replace any compromised materials and clean the storage environment. Use separate tools and containers for affected items.

Recurring inspections and maintenance are crucial, but balance and caution are key. Overdoing inspections or using materials excessively can lead to unintended consequences. Handle comics carefully, monitor environmental conditions, and use archival materials wisely to ensure the long-term preservation of your collection.

Further conservation guidance and recommended reading material is available under following link: https://www.loc.gov/preservation/about/faqs/paper.html.

Preferred Solution for Archival Preservation

In particular, archival-grade plastic bags can offer good protection from external pollution and cross-contamination between comics. Note that the composition of the plastic is key, as many of the plastic materials available (e.g., cellulose acetate, PVC, polypropylene with additive or coatings such as flame retardants) can release acidic volatile compounds such as acetic acid (Curran, 2014), which can severely contribute to the degradation of comics (Strlič, 2011). Furthermore, plastic bags may acidify comic books and trigger oxidation or even release

[11] https://www.ifla.org/paper-conservation-by-using-japanese-paper-washi/

colored byproducts causing change in color. Hence plastic bags should be chosen carefully based on the chemical stability of the underlying composition of the plastic.

Mylar (Type D[12]) is known for the superior chemical stability[13] (Taylor, 1985) compared to cheaper polyethylene plastic bags, has an increased UV-screening, and because of increased stability, minimal VOC release is expected – this too renders type D Mylar bags as the best choice for archival conservation. Mylar polyester film is indeed widely recognized as the gold standard for the preservation of particularly fragile documents adopted by conservationists and institutions around the globe[14], offering unparalleled protection against various forms of damage (Library of Congress Preservation Office, 2009), (Library of Congress Preservation Office, Research Services, 1980). Similarly, compared to other plastic bags, Magicover Mylar comic book sleeves, made from a durable, chemically inert polyester type D film, provide long-lasting protection, ensuring that comics remain in excellent condition over time. Magicover Mylar comic sleeves offer a multi-layered defense against environmental, physical, and chemical risks, making them an essential tool for serious comic book collectors.

- **Mechanical Stress**: Magicover Mylar comic bags offer a rigid enclosure that protects comics from bending, warping, and damage caused by regular handling. The structural integrity of the sleeve prevents mechanical stress, preserving the comic's shape and preventing wear and tear.
- **Chemical Damage**: Magicover Mylar comic bags act as a barrier against harmful substances such as acids and pollutants. They shield comics from damaging gases, moisture, and external acidic materials, reducing the risk of yellowing, brittleness, and other forms of deterioration.
- **Pest Damage**: Magicover Mylar comic bags create a sealed, pest-proof environment that protects comics from physical damage caused by insects and rodents. The durable material prevents pests from accessing and damaging the comics, offering an added layer of protection.
- **Cross-Contamination**: In cases where some comics have already been damaged by mold, mildew, or acidic compounds, Magicover Mylar comic bags help isolate these affected comics from the rest of the collection. By preventing cross-contamination, they ensure that damage doesn't spread to other valuable items.

With their ability to protect against mechanical, chemical, pest-related, and cross-contamination threats, Mylar sleeves are a critical investment for any collector serious about preserving their comic books for the long term.

[12] https://cool.culturalheritage.org/byorg/abbey/an/an13/an13-5/an13-507.html

[13] https://www.nps.gov/museum/publications/conserveogram/18-02.pdf
https://cool.culturalheritage.org/coolaic/sg/bpg/annual/v04/bp04-12.html

[14] Often conservation of valuable documents and paper artifacts involve encapsulation with Mylar/Melinex PET film:
https://psap.library.illinois.edu/collection-id-guide/laminationencapsulation
https://museum.wa.gov.au/research/development-service/encapsulation
https://www.canada.ca/en/conservation-institute/services/conservation-preservation-publications/canadian-conservation-institute-notes/encapsulation.html

Magicover Mylar Comic Bags are long-lasting, durable, and effective in preventing damage, reducing the need for frequent replacements and costly repairs. There is also less need for regular maintenance and re-bagging, with superior protection reducing ongoing preservation efforts.

Other Common Plastic Sleeves are prone to damage and degradation, requiring more frequent replacements and potentially leading to higher costs for restoration. They are also more time-consuming, as they require increased effort for maintenance and monitoring due to lower protective qualities.

In conclusion, while the initial cost of Magicover Mylar comic bags may be higher than other plastic sleeves, their long-term benefits in terms of durability, protection, and cost-effectiveness make them a more economical and efficient choice for preserving comic books.

Archival Paper

Archival paper[15] is a type of acid-free paper, and there are various types with differing levels of effectiveness in preventing the migration of contaminants, regulating humidity, controlling paper acidity, and serving as a buffer against environmental fluctuations. These papers are designed to slow down paper degradation, yellowing, and brittleness, with some offering more efficient preservation than others, depending on their specific properties. Collectively, these characteristics help preserve the integrity and longevity of materials over time. A particular buffered archival paper with infused zeolites, the so-called ZEO paper (by Tvartcomics /Magicover) or equivalent MicroChamber Interleaving Paper by Conservation Resources International (Rempel, 1996), offers enhanced protection by absorbing and neutralizing harmful gases, which contributes to slowing down aging more effectively than common archival paper.

- **Chemical Damage:** All types of archival paper help mitigate cross-contamination and pollutant migration from damaged paper materials or from acidic storage materials and mold. These (i.e., common, pH-neutral sheets) may not actively neutralize existing acids. **Deacidification Archival Sheets** are alkaline-buffered and are hence particularly useful for neutralizing existing acids within the comics, preventing further acid-based deterioration. However, **ZEO / MicroChamber Interleaving Paper** goes further by absorbing additional pollutants and acidic byproducts, providing an extra layer of chemical protection.
- **Pest Damage:** Archival paper contributes to maintaining a stable environment, which helps control humidity and deters pests. While all archival papers assist in reducing the likelihood of pest infestations, **ZEO / MicroChamber Interleaving Paper** adds additional protection by absorbing gases that could attract pests, offering a cleaner and less attractive environment for pests than common archival paper alone.
- **Cross-Contamination:** Archival papers help prevent cross-contamination by shielding from or even absorbing pollutants and harmful gases that could transfer from one comic to another. **Deacidification Archival Sheets** helps limit cross-contamination by neutralizing acids, particularly in collections where acidic content might spread to neighboring items. **ZEO / MicroChamber Interleaving Paper** excels in this role by actively trapping and neutralizing contaminants, making it superior to common archival paper for protecting adjacent comics from chemical pollutants.

Archival papers such as ZEO / MicroChamber interleaving paper and deacidification paper are all used in the preservation of valuable documents, including comic books, but they have different properties and functions. As indicated above, ZEO / MicroChamber paper is a most advanced and specialized type of archival paper designed not only to protect against acids but also to absorb and trap harmful pollutants, by-products from degradation, and other contaminants. ZEO / MicroChamber paper contains activated carbon and zeolites, which are materials capable of absorbing and neutralizing harmful pollutants such as sulfur dioxide, nitrogen oxides, and other off-gassed chemicals that can accelerate the deterioration of

[15] For the sake of simplicity, we will refer to archival paper in this document as any acid-free (i.e., with at least neutral pH ~7) paper whose minimal application is to prevent cross-contamination and pollutant migration between comics or paper materials. For more details and comparison see Table 2: Archival Paper Definition and Classification.

paper and ink. Consequently, ZEO / Microchamber is highly effective for odor removal due to its activated carbon and zeolites, which actively absorb and neutralize odor-causing chemicals. Ideal for situations where items have developed strong odors due to poor storage conditions, such as mustiness, smoke, or environmental pollutants.

In summary, ZEO / MicroChamber paper offers the most advanced protection by addressing both internal and external threats to comic books and other paper-based items, whereas common archival paper and deacidification paper are more focused on specific aspects of acid management. Micro-chamber interleaving paper is ideal for preserving items in environments where pollutants are a concern, such as in urban areas with high pollution or in storage situations where off-gassing from other materials could be an issue.

Property	**Archival (Non-buffered) Paper**	**Deacidification (buffered with 2-3% calcium carbonate) Paper**	**ZEO / MicroChamber Paper**
pH	**Neutral (~7)**	**Alkaline 8.5-9.0**	**Infused Zeolites**
Primary Function	Provides acid-free environment	Neutralizes existing acids in the paper	Absorbs and neutralizes pollutants, gases, acids
Pollutant Absorption	None	Minimal	High
Acid Neutralization	None	Direct (neutralizes existing acids)	Indirect (absorbs acidic gases)
Odor Removal	None	Indirect odor reduction by acid neutralization	Actively absorb and neutralize odor-causing substances.
Cost	Moderate	Higher	Higher
Use Case	General preservation to prevent acid migration	Restoring and stabilizing acidic materials	Long-term protection from internal and external pollutants

Table 2: Archival Paper Definition and Classification

Common Archival Paper (pH-neutral) is a good, cost-effective option for general protection from acid migration but does not provide active protection against pollutants and is ineffective at addressing odor issues. Deacidification (alkaline buffered) *p*aper is specifically useful for stabilizing materials that are already acidic and at risk of degradation due to internal acids. It is however only marginally useful for odor control, with no significant impact on external smells. ZEO / *MicroChamber* Interleaving Paper is the most comprehensive in terms of protecting against pollutants and gases, making it ideal for long-term preservation of valuable comic books.

Combined Use of Magicover Mylar Comic Sleeves and ZEO Archival Paper

Using only one of Mylar sleeves or archival paper for comic book preservation is generally insufficient because each material addresses different aspects of preservation. Isolated usage of one or the other provides partial protection but does not fully address all preservation needs. Mylar sleeves protect against physical damage and pollutants but do not fully manage humidity or chemical interactions. Archival paper buffers against acidity and can absorb some moisture but does not prevent physical handling issues. Combining both Magicover Mylar comic bags and archival paper offers comprehensive protection by addressing physical, chemical, and environmental factors, ensuring the long-term preservation of valuable comic books.

In summary, using Magicover Mylar comic book sleeves in conjunction with archival paper offers a synergistic approach to comic book preservation. The Magicover Mylar comic sleeves provide essential physical protection, while the ZEO / MicroChamber paper manages the environmental conditions that can lead to degradation. Together, they create an optimal preservation solution that effectively addresses a wide range of potential risks. For optimal preservation results we recommend combining mylar sleeves and ZEO / MicroChamber interleaving paper. When used in a closed environment such as a sealed display case, molecular traps in the ZEO / MicroChamber paper "capture and remove the harmful molecules that pass by the alkaline buffer. Their efficacy in a more open system such as a document storage box is expected to be less" - see https://www.nedcc.org/free-resources/preservation-leaflets/4.-storage-and-handling/4.4-storage-enclosures-for-books-and-artifacts-on-paper.

Overall, Magicover Mylar comic bags and ZEO / MicroChamber paper combined offer:

- ✓ **Comprehensive Protection:** The combination provides a multi-dimensional approach to preservation, addressing both physical and chemical risks. This comprehensive strategy is crucial for maintaining the condition and value of comic books.[16]
- ✓ **Ease of Use:** For the average collector, using Magicover Mylar comic book bags and ZEO / MicroChamber is a straightforward and effective way to implement robust preservation practices without requiring specialized equipment or expertise.
- ✓ **Long-Term Benefits:** By addressing immediate physical threats and long-term environmental factors, this combination helps ensure that comic books remain in excellent condition for years to come.

See also a discussion paper The Mechanisms and Causes of Paper Deterioration by William K. Hollinger of Conservation Resources and CGC reference to application of ZEO / MicroChamber paper.

[16] Additional benefits of Combining Magicover Mylar Comic Bags and Archival Paper are: Visibility of Covers: When archival paper is placed inside the comic book, it maintains the visibility of the covers and pages, allowing for display and easy access without removing the comic from its protective environment..

Practical Application of Magicover Mylar Comic Sleeves and ZEO Archival Paper

To implement this optimal preservation solution:

i. **Place ZEO Archival Paper Inside the Comic Book**: Insert ZEO archival paper into the comic book to aid in the absorption of off-gases released by the comic. Placing the paper inside rather than on the outside helps maintain the cover's visibility and maximizes the absorption of off-gases released by the comic. For enhanced protection, place sheets of archival paper at the beginning, middle, and end of the comic book. Optionally, If the comic book has a removable cover or if you're particularly concerned about the cover's condition, you can place a sheet of archival paper between the cover and the first/last page of the comic. We generally recommend placing one ZEO / MicroChamber sheet in your comic for every 20 to 40 pages.

   Depending on the comic's thickness and your preservation needs, use more sheets per comic book to balance added thickness and protection. Choose from:

   - **ZEO / MicroChamber Paper**: Offers advanced protection by combining alkaline buffers with molecular traps to neutralize acids and capture harmful gases.
   - **Deacidification Paper**: Provides effective acid neutralization and buffering, helping to prevent paper degradation.
   - **Non-buffered Paper**: Delivers basic pollutant and contamination prevention, suitable for general use but lacking advanced gas absorption capabilities.

   For most collectors, using either ZEO / MicroChamber paper or deacidification paper alone, in conjunction with Magicover Mylar comic book bags, will typically offer effective preservation. Combining all three types of paper may be beneficial in highly specialized cases where maximum protection is required, but it is generally not necessary for standard preservation practices. Evaluate your collection's specific needs, environmental conditions, and budget to determine the most appropriate approach.

ii. **Enclose the Comic Book in a Magicover Mylar Comic Book Sleeve**: Place the comic book, now containing archival paper (recommended ZEO / MicroChamber), into a Magicover Mylar comic book bag. This adds an extra layer of protection against physical damage, UV light, and external contaminants.

iii. **Store Properly**: Store the bagged comic book in a cool, dry place away from direct sunlight and extreme temperature fluctuations.

In summary, using Magicover Mylar comic bags in combination with different types of archival paper - such as ZEO / MicroChamber paper or other alkaline buffered papers - offers a comprehensive and cost-efficient approach to comic book preservation. Magicover Mylar comic book sleeves provide essential physical protection by shielding comics from moisture, dust, and pollutants, effectively safeguarding them from external damage. ZEO / MicroChamber paper enhances this protection by incorporating alkaline buffers and molecular traps, like zeolites or activated carbon, which actively neutralize acids and capture harmful gases that might otherwise contribute to degradation. Together, these combinations create a tailored preservation system that addresses a wide range of physical and chemical risks, ensuring cost-effective optimal long-term care for comic book collections.

Other Archival Products and Treatments

Do-It-Yourself Deacidification

When a home-made deacidification treatment is considered needed, we recommend the Bookkeeper by Preservation Technologies. Bookkeeper is the most suitable for home use as this is a non-toxic, non-invasive and easy-to-use deacidification solution. In particular, Bookkeeper suspension is virtually odor free and dries in minutes. Bookkeeper does not damage inks, adhesives, or binding materials. It is non-clogging, non-toxic, non-hazardous, non-flammable, and is completely safe for the user and the environment.

The final pH of the paper following treatment depends heavily on the paper composition prior to treatment. The range of possible pH results is between 7 and 10, and typical results are in the range of 8.0 - 9.5. Sufficient alkaline material is added to the paper to provide a protective alkaline reserve. Over the first few weeks following treatment, the magnesium oxide particles combine with moisture in the air to form magnesium hydroxide, also a non-toxic alkaline buffer. These buffer particles readily absorb and neutralize the acids in the paper. The material continues to absorb acid over the life of the paper. This is a permanent treatment that does not need to be repeated under normal storage conditions.

Other major deacidification solutions are likely less suitable as may require professional treatment as are complex to apply in home environment or may cause color bleeding. (Save Paper, 2006).

Archival Boxes and Backing Boards[17]

Proper storage is crucial for preserving the condition and value of comic books. Effective storage protects comics from physical damage, chemical degradation, and environmental factors that can compromise their longevity. Using high-quality archival materials, such as acid-free archival boxes and backing boards, may substantially add to safeguarding these valuable items. Archival boxes offer structural protection, while backing boards maintain the shape and integrity of individual comics. Combining these tools with Magicover Mylar comic book sleeves and archival ZEO / MicroChamber paper and employing appropriate storage practices ensures

[17] **Soft-cover comic books may specifically benefit from archival backing boards**. Archival backing boards can be used to provide structural support to maintain the shape and prevent physical distortion. I.e., it may prevent bending, warping, and creasing by offering a rigid backing, especially when comics are stored upright or on shelves. These boards add to the cost and require additional space; however, they may be crucial for valuable or delicate soft-cover comics. They may complement thinner mylar sleeves and archival paper by ensuring that physical deformities are prevented. **Trade-Offs: 1. Visibility:** Using archival boards inside Mylar sleeves may obscure the comic book's visibility if the boards are too thick or if the Mylar sleeves are not clear enough. For collectors who wish to display their comics, this can be a disadvantage. **2. Accessibility:** Archival boards can make it more cumbersome to remove and handle comics frequently. For collectors who regularly access their comics, the added rigidity may be less convenient. However, this trade-off is typically justified by the added protection against physical damage.

that comics remain in optimal condition over time. This is especially important for damaged or fragile books.

Use Archival Boxes and Backing Boards

- **Archival Boxes:** Ensure that the boxes are constructed from acid-free, archival-quality materials. Store comics upright in the boxes to prevent bending and warping. Keep the boxes in a cool, dry place away from light and fluctuating temperatures. Regularly inspect archival boxes for any signs of wear, damage, or deterioration such as tears, holes, or creases. Look for damage from moisture, mold, or pests. Ensure they are not exposed to excessive moisture or direct sunlight, which can degrade the material over time.
- **Backing Boards:** Place backing boards against comics to maintain structural integrity and prevent sagging. Replace any damaged or degraded boards to ensure ongoing support and the boards are not causing any damage to the comics, such as indentations or pressure marks. Periodically verify that backing boards are still providing adequate support and have not warped or degraded. Ensure that the backing boards do not have sharp edges or corners that could damage the comics.

Avoid overloading archival boxes with too many comics, as this can cause deformation or damage. Follow manufacturer guidelines for the maximum number of comics per box. Do not use non-archival boxes or backing boards, as they can introduce acids and contaminants that damage the comics over time.

Consulting Professional Conservators

There are preservation solutions that may not be suitable for *Do-It-Yourself* approaches and could require the assistance of professional conservators. Consulting with these experts is particularly important in the following situations:

- **Complex Deacidification**: Professional conservators have access to advanced deacidifying techniques and equipment for neutralizing or buffering acids in paper[18] and other materials, which can significantly prolong their lifespan.
- **Physical Damage**: For extensive repairs and specialized handling techniques, conservators provide expert services to address issues such as tears, creases, and structural damage that require precision and skill.
- **Chemical Damage**: Conservators can perform specialized treatments to address and mitigate acid damage, mold, and other chemical-related deterioration that might be beyond the scope of standard preservation methods.

[18] Common deacidifying methods and products include: 1. Buffering Agents: These chemicals are used to neutralize acids within materials, 2. Deacidification Sprays: Applied to paper surfaces to neutralize acids and prevent further degradation, 3. Deacidification Baths: Involve immersing materials in a solution that neutralizes acids, 4. Deacidification Foams: Used to treat surfaces with controlled application. These methods help maintain an alkaline environment that can significantly extend the life of paper and other materials.

- **Pest Damage**: Severe infestations or damage from pests, such as insects or rodents, often require professional intervention to ensure comprehensive treatment and prevent further harm.

Acknowledgements

This paper would not have been possible without the generous support and expertise of several individuals whose contributions were instrumental in shaping the scientific foundation and practical recommendations herein.

I express my deep gratitude to academic researcher **Prof. Alfonso Zoleo from Department of Chemical Sciences at University of Padova in Italy**, for his invaluable scientific supervision and guidance throughout the research phase. His insights into material stability and degradation mechanisms greatly enhanced the rigor of our preservation analysis.

I also thank **Consuelo Martínez Rendo**, **Director at Preservation Technologies for Europe and Latin America, seasoned paper conservator and microbiologist**, for sharing her knowledge on the biological threats affecting cellulose-based materials and for her practical input on conservation treatments tailored to comic book collections.

Their collective expertise ensured that this work is grounded in scientific accuracy and aligned with the needs of collectors, archivists, and preservation professionals worldwide.

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