Vinyl Windows

Designed for Performance

A presentation for vinyl windows by AAMA
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Learning Objectives

• What is Vinyl?
• Performance Characteristics of Vinyl
• Extrusion Process and Certification
• Manufacturing Process and Industry Standards
• Case Studies of vinyl window applications
Manufacturing Raw Material

Building blocks derived from salt and petroleum

Vinyl Chloride monomer gas polymerizes to powder resin, a clean controlled and automated process

High-tech compounding and unique processing techniques yield vinyl’s versatility
Manufacturing Process
What is Vinyl?

- Largest Volume Plastic in Building & Construction
- 2/3 of Vinyl Manufactured for Building & Construction Applications
- Versatility – Flexible, Rigid, & Customized Applications Can be Made in Colors, Patterns, or Textures
- Combines Many Characteristics of Traditional Materials with Advanced Technologies
1926

The Beginning
While working at BF Goodrich, Dr. Waldo Lonsbury Semon invents modern day vinyl

1940

World War II
Vinyl jacketed wiring replaces rubber insulation and textile jacketing on naval ships

1945

Post War Era
Materials shortages lead to vinyl window frames; wallpaper coating, durable flooring emerge

1950

The 1950’s
Windows improved for U.S. market; advent of PVC pipe critical to global clean water delivery
Vinyl Timeline

1955
B.F. Goodrich
Independently develops Koroseal PVC storm window extrusion in U.S.

1960's
The Rise of Vinyl
Vinyl siding introduced and improved as aluminum costs rise

1964
First PVC Replacement Window in U.S.
Single glazed side load DH by Thermal Industries

1970's
Effective Material
Single-ply roof membranes alternative to built up roofs as asphalt costs rise
Vinyl Timeline

**Demand For Vinyl**
Oil embargo and high aluminum prices spur demand for energy saving products

**Vinyl Advances**
Vinyl overtakes top market share position from wood and aluminum

**A New Market**
Vinyl fencing new market for recycled post-industrial waste; decking and railing evolve

**Here To Stay**
Versatile vinyl has vital role in the built environment; technology advances, new uses discovered rapidly
Weatherability

What is Weatherability?

weatherability

1.) capability of withstanding the weathering process (weatherability of vinyl)

Weatherability is the ability to retain color and physical properties (i.e., appearance, texture etc.) over a period of time with exposure to the elements.
Case Study

Location: Swiss Alps

Challenge: Low Temperatures, High Winds

Solution: Commercially-Rated, Steel Reinforced Vinyl Windows
Weatherability

Color Retention

- Over time, colors can change or fade
- Vinyl formulation technology to counteract
  - TiO₂
  - Weathering Pigments
  - UV Inhibitors
Weatherability

Impact Resistance

Part of AAMA’s Lineal Certification

- Missile Impact Test
- Testing before and after Weathering
- Pressure Test
- Drop Impact Test
Weatherability

Dimensional Stability

– Coefficient of Linear Expansion

– Heat Build-Up Characteristics

– Temperature Buildup

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<tr>
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</tbody>
</table>
Case Study

Location: High Desert, Colorado

Challenge: Fast & Extreme Temperature Cycles

Solution: Vinyl Windows & Doors
Chemical Resistance

- Pesticides and other household chemicals
- Corrosive conditions
- Moisture

Case Study: PVC Success in Water (Pipe Applications)
Case Study

Location: Puget Sound, Washington

Challenge: Salt Air Corrosion, High Maintenance, Energy Costs

Solution: Commercially-Rated Vinyl Windows & Doors
Fire Resistance

- High ignition temperature
- Does not support combustion
- Combustion products
- Smoke characteristics
Performance In Windows

- Low Maintenance
- Energy Efficiency
- Design Flexibility
- Environmentally Friendly

A variety of products can profit from the qualities of vinyl.
Low Maintenance

- Clear through color means no need to touch up due to scratches
- Does not rot, chip, or peel
- Is not susceptible to insect attack
- Easily cleaned with soap and water
Case Study

Location: Bellevue, Washington

Challenges: Create Desired Appearance, Save Energy, Low Maintenance

Solution: Vinyl Windows with True Divided Lites & Doors
Energy Efficiency

- Thermal Barrier - Lower Energy Consumption
- Reduced Dependency on Crude Oil
- Reduced Energy to Manufacture
Case Study

Location: Saratoga Springs, NY

Challenge: Save energy in a large atrium of a retirement community where utilities are included

Solution: Energy efficient vinyl windows and patio doors
Environmentally Friendly

- Reduced Scrap
- Recyclability
- No Need for Paints, Solvents, or Insecticides
- Life Cycle Costs
100% of manufacturing scrap is recyclable

One billion pounds of vinyl were recycled in one year.

Vinyl windows are so durable that the vast majority of them installed over the past 25 years are still in use.
Design Flexibility

- A Wide Range of Profile Shapes
- Easily Manufactured in Custom Sizes and Configurations
- Easily Bent into Shapes
Case Study

Location: Pier Rebuild, Lake Michigan

Challenges: Fit to Old "Custom" Openings, Save Energy, Easy Maintenance

Solution: Custom Vinyl Windows
Range of Vinyl Window & Door Products

**Traditional Product Types:** Hung, Sliding, Casement, Picture, Awning, Bay, Bow, Patio Door, Hinged Door

**Popular Configurations:** Full rounds, Half rounds, Hexagons, Trapezoids, Quarter rounds, Ellipticals, Triangles

**Art Glass:** Beveled, V-grooved, Stained glass

**Composite Products:** Laminated foils, veneers and stained wood fiber composites provide the look of wood on the inside, combined with the maintenance-free vinyl on the exterior
The Super Window

**Goal:** Energy Saving Windows

**Multi-Chambered Vinyl Frame:**
U-Value, Condensation Resistance and Sound Control

**Spectrally Selective Glazing:**
Solar Heat Gain Coefficient (SHGC)

**Passive Solar Gain:**
Electrochromatic Glazing

Automated / Remote Control
Exterior Colors/Interior Finishes

Extruded Color

Co-Extruded Color
Exterior Colors/Interior Finishes

Laminates

Paint Process
Case Study

**Location:** Pinnacle Lofts and Condominiums - Portland, OR

**Challenges:**
1. Design a sleek and modern mixed-use building that celebrates the views of Portland's Pearl District
2. Match anodized finish of other products used in the building
3. Achieve energy efficiency

**Solution:** Commercially-rated vinyl windows with co-extruded capstock
Growth of Vinyl Windows (United States)

New Construction (millions of units)

Growth of Vinyl Windows (United States)

Remodeling & Replacement (millions of units)

Growth of Vinyl Windows (United States)

Total Construction (millions of units)

Current United States Market Share

2005 Total Residential Windows

- Vinyl: 58%
- Wood: 27%
- Aluminum: 12%
- Fiberglass: 2%
- Other: 1%

2009 Projected United States Market Share

2009 Projected Residential Windows

- **Wood**: 25%
- **Aluminum**: 12%
- **Vinyl**: 60%
- **Fiberglass**: 2%
- **Other**: 1%

Manufacturing

1.) Specially formulated vinyl compound

2.) Twin Screw extruders push compound into extruder

3.) High speed dies define the shape of the profile

4.) Calibration tables and water baths remove the heat from the extrusions to ensure performance and design tolerances

5.) Advanced technology monitors the process to assure quality assurance

Vinyl Extrusion Line
AAMA PVC Lineal Certification Program

- Vinyl Windows are Fabricated with PVC Profiles that Undergo Extensive Physical Testing by an Independent Certification Agency
  - *Dimensional Stability*
  - *Drop Dart Impact Resistance*
  - *Weatherability*
  - *Heat Resistance*
Case Study

**Location:** Florida

**Challenge:** Hurricane Season

**Solution:** Impact-resistant windows
Fabrication Process and Industry Standards

Welded Corners
Provide Strong Seals
Making Vinyl Windows
Air and Water Tight
Fabrication Process and Industry Standards

Automated Equipment Ensures Precision and Quality Throughout the Manufacturing Process
Fabrication Process and Industry Standards

~50 AAMA VMC member manufacturers

~170 total AAMA VMC members
Vinyl windows are tested to the same structural performance standard as aluminum and wood windows.
Case Study

Location: Wesleyan College, Kentucky

Challenge: Replace Tornado Damaged Windows - Retain Historical Appearance

Solution: Vinyl Windows
Vinyl Windows are tested to the same thermal test standard as aluminum and wood windows.

U-Factor and Solar Heat Gain are reported.

Vinyl windows are energy efficient due to the non-conductive nature of vinyl.

- Rain and Water
- Storms and Wind
- Extreme Temperatures
- Snow and Ice
**Thermal Performance**

### U-Factor* Range for Vinyl Frame Materials

<table>
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<tr>
<th>Frame Material</th>
<th>U-Factor</th>
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<tr>
<td>Vinyl</td>
<td>0.3-0.5</td>
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<tr>
<td>Insulating Vinyl</td>
<td>0.2-0.4</td>
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* A measure of the rate of non-solar heat loss or gain through a material or assembly. The lower the U-factor, the greater the window’s resistance to heat flow and the better its insulating value. U-factor is equivalent to 1/R-value.

Case Study

Location: Senior Housing Project, Chicago

Challenge: Comfort in Midwest Heat and Cold, Ease of Use

Solution: Custom Fit Vinyl Replacement Windows
Case Study

Location: Klondike Inn, Alaska

Challenges: Endure Extremely Brutal Winter, Supply Comfort, Save Energy

Solution: Vinyl Windows
Energy Star Program

Vinyl windows perform very well with the ENERGY STAR program requirements.
Vinyl Windows are Tested and Certified in the AAMA Certification Program for Both Residential and Commercial ratings.
Vinyl Windows Designed for Performance

American Architectural Manufacturers Association
Seminar Evaluation

Please take a moment to complete the evaluation form.

Thank You.