Sterile Barrier Packaging: Common Causes of Failures and How to Prevent Them

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Sterile Barrier Packaging: Common causes of failures and how to correct them

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Agenda

- Purpose of Packaging
- Standards
- Test Methods/Failures
- Sample prep
Purpose of Packaging Testing

• Evaluate the performance of each sterile barrier system or packaging system before selection and implementation to ensure conditions for sterilization, storage, and handling.

• Can be a requirement – FDA

• Can be guidance – European ISO
FDA Inspection Categories
(observed during review of sterilization validation)

1) Supplier Problems
   New supplier/material not qualified
   Packaging process not validated
   Pin holes

2) Design
   Device in the seal
   Sharp edges
   Package too small
   Wrong packaging configuration
FDA Inspection Categories (cont.)

3) Production and Process Controls
   - Improper line clearance
   - Incorrect parameters used for sealing
   - Equipment changes not validated

4) Personnel Problems
   - Not following procedures
   - Inadequate training
   - Not following procedures
Current Standards

ANSI/AAMI/ISO 11607 part 1 & 2

Part 1: Materials and Sterile Barrier Requirements

Part 2: Forming, Sealing and Assembly

Approved as the FDA consensus standard
ISO 11607

The document divides the testing into 2 separate area’s:

• Performance Characteristics –
  – temperature, humidity, pressure, light, cleanliness, electrostatic conductivity

• Package Properties
  – microbial, physical and chemical properties, sterilization compatibility
ISO 11607

• Evaluated through all intended processes
  – Sterilization
  – Handling
  – Distribution
  – Storage

• Include all materials – IFU, labeling
• Evaluated for expected worse case scenarios
  – Medical Device (heavy, light, sharp)
  – Material (porous, nonporous)
  – Manufacture parameters (sealing)
  – Sterilization (single, multiple)
  – Distribution, storage, handling
Typical Validation Plan

- **Shipping studies early-feasibility**
- **Ship prior to all performance & stability tests**
- **Perform 3 tests: strength, integrity, microbial**
- **Perform baseline testing - Performance**
- **3 lots/batch of 11 samples**
- **Use same tests throughout**
- **Minimum of 3 points for entire process**

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# Common Packaging Tests

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Packaging tool

Available at Nelson Labs Booth #812
Visual Inspection is a process of methodically and purposefully examining a package for a specific range of defects and recording observations.
Visual Inspection

Channels

Bubble test failure, due to channels in the seal. The area circled in red, shows the emission of bubbles from a single point in the seal.

Dye Migration failure, due to channels in the seal. The channels are indicated by the areas where the blue dye traveled through the entire width of the seal.
Example of crease through a seal.
Visual Inspection
Undersealed

Open seal

Nonhomogeneous seal, lacks uniformity in color.
This is an example of an opened seal on a Tyvek pouch

- Package misalignment in sealer.
- Equipment malfunction of the sealer.
- Defects within the material being sealed or foreign body in the seal.
- Seal rupture after the seal was made.
Visual Inspection

Oversealed

Clarified Seal

Slightly clarified seal

Oversealed foil pouch

Leakage through a seal, due to oversealing of Tyvek
Visual Inspection
Narrow Seals

Narrow Seal, due to tray misalignment

Narrowing of seal, due to internal creep, which was caused by warping of the tray

Narrow Seal, due to internal creep
Seal Peel Test
Seal Peel Test
ASTM F88

Determines the strength of the seal at a specific place on the package

2 seals
- Manufacturer’s
- MDM Seal

Can be helpful in setting the sealing parameters during IQ testing

Measure a one inch segment of the package along one of the seals.
- cut the package so that there are 3 inches of material on each side of the seal

Results are reported as load at yield and energy to break

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Identifying the material in each grip is critical as it can have an affect on the results.

Tyvek in mobile grip

Film in stationary grip

1 inch across
Seal Peel Test

90° Unsupported

Usually provides the most conservative value (lowest)

Tail is free floating during the pull
90° Supported

Tail is manually held with slight pressure during the pull
180° Supported

Provides values significantly higher than with tail in 90 ° position. Plate is placed in the stationary grip.

Tail is held with a backing plate during the pull
Seal Peel Test

Over sealed as a result of too high temperatures causing melting/bending of materials and voids in the seals.
Seal Peel Test

Delamination as a result of too high temperatures causing fiber tear.
Burst Test
ASTM F1140

Determines package seal strength

Perform by pressurizing the package until it bursts

Test system pressure is pre-set to a point above the known burst point

Results include the burst pressure data and a description where the seal failure occurred.

• This provides a better idea of where the stress points are located
Burst Failures
Dye Migration Test
ASTM 1929

Determines the integrity of the package seal

Involves injecting dye into the package
• Placing the weight of the solution against each portion of the seal for a specific length of time

Examine package for evidence of seal failure
• Demonstrated by dye slipping through the seal
Dye Migration Failure
Dye Migration Failure

~125um

~75um

~50um
Dye Migration Failure
Determine the integrity of the package and the seal

Involves inflating the package and submerging it into a surfactant solution

Package examined for evidence of seal failure or holes in packaging, demonstrated by bubbles emerging through the seal
Bubble Emission Failures

Tyvek® folds
Bubble Emission Failures
Microbial Ranking Test
ASTM F1608

Determines the Log Reduction Value (LRV) of porous material

Sample size must be a minimum of 47mm in width

Packages placed into a chamber and exposed to a specific organism (Bacillus)

Filters are blended and plated to determine titer values
Microbial Ranking Test
Microbial Aerosol Challenge

Determines the integrity of the whole package

Packages placed in an aerosol chamber and exposed to a specific organism (Bacillus) Contents of the packages are then tested for the presence/absence of the indicator organism
Microbial Aerosol Challenge

Indicator testing

- Immersion
- Flush
- Media fill
ASTM F2638

- Measures aerosol filtration performance of porous materials
- Results in the max penetration of material
- Uses 1.0 μm latex spheres
Sample Prep
Sample Preparation

- Packages should be manufactured in a validated process
- Must be sterilized using validated sterilization processes including multiple exposures
- Should include device/facsimile labeling and IFU’s
• Microscopic examination
• Risk analysis
  – Fishbone diagram
  – Failure Mode Effectiveness Analysis (FMEA)
  – Flow diagrams
  – In-process reviews
Other tools...

- Test method validation
  - Precision and bias
- Look at Product, Process, Package, People and Environment
Thank you

Don’t forget – the slide rule is available at Nelson Labs Booth #812

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