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Architectural Testing

Understanding Plastics in Building Products

February 2015

Presenter: Kimberly Stuart

Webinar Outline

Part One

- ❑ Plastics in Building Products
- ❑ Plastics in the Supply Chain

Part Two

- ❑ FAQs
- ❑ Useful Resources

Plastics in Building Products

Polymer (Plastic)

Common categories of properties analyzed include:

- Mechanical – a materials response to stress or strain
- Electrical- how does a material respond to electricity across or through the material
- Optical – quantifying a materials appearance
- Rheology – how does a material flow
- Thermal – a plastics response to heat
- Barrier – how gases or vapors permeate a material

Defining Polymers in Building Products

Polymers	Advantages	Industry Examples
Plastics (Resins)	Commercially available	Hardware, Door, Insulation, Finishes,
Rubber	Elastic, damping, insulating	Gaskets, Flooring, Dampers, Plumbing
Composites (reinforced)	Strength-weight ratio, corrosion resistant	Decking, Wall Systems, Manufactured Housing
Adhesives	Alternative to fasteners	Tapes, Solar Panels, Roofing, Sealants
Film	Barrier	Weather barriers, Glazing, Coatings, Packaging

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Supply Chain Questions

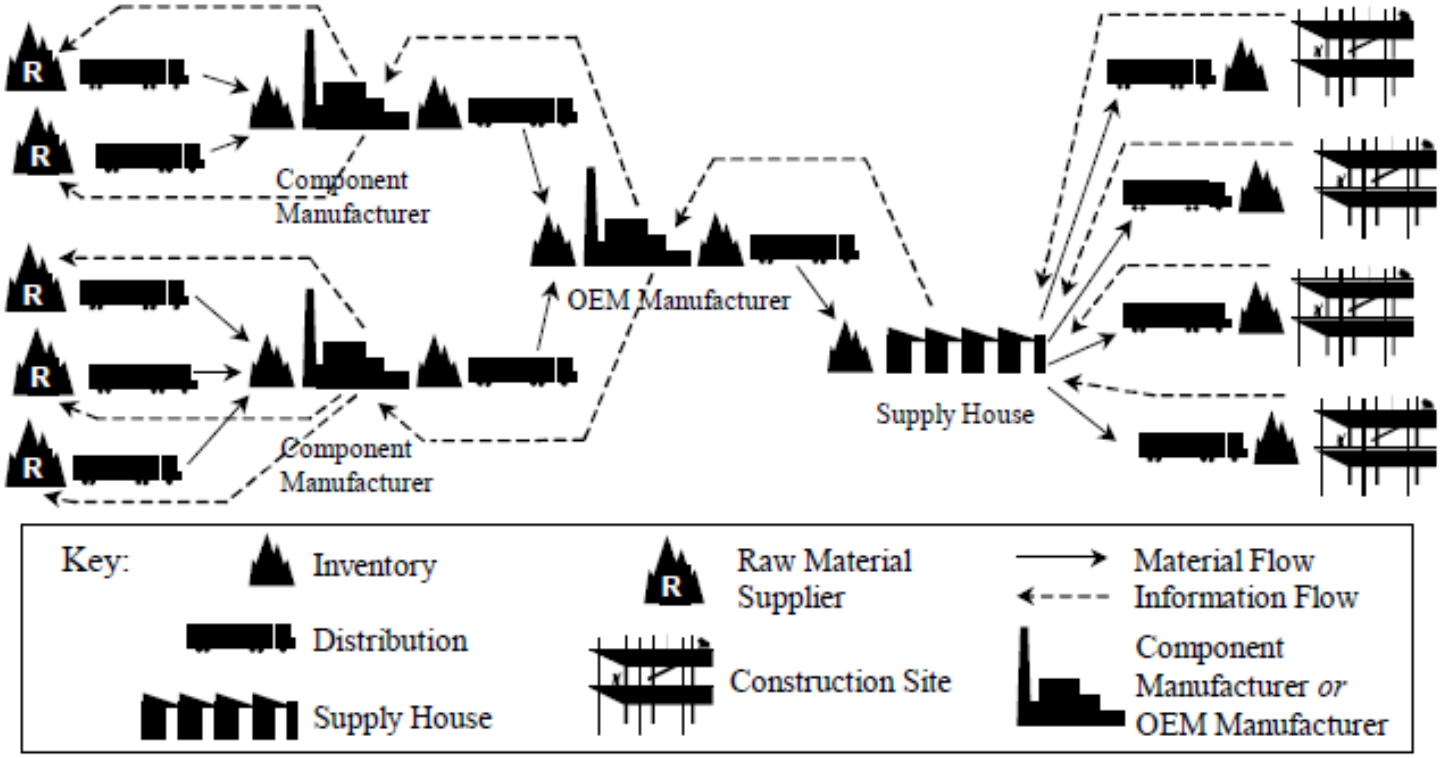

Figure 1: Example of a Construction Supply Chain for a Building Material

CONSTRUCTION SUPPLY CHAIN IMPROVEMENTS THROUGH INTERNET POOLED PROCUREMENT, *26-28 July 1999, University of California, Berkeley, CA, USA,* John Taylor and Hans Bjornsson

Why Standardized Testing?

- Comparable Data (eliminate variables in testing, specimens, preparation, conditioning)
- Industry Accepted
- Technical Committees develop and maintain ASTM standards
- Industry Certifications (ISO 17025)

Frequently Asked Questions

Front End Materials Characterization

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Common material testing techniques to answer

- **New Product:** Do I test to a material or product specification?
- **Identification:** What is this material?
- **Processing:** Is there degradation? Are there voids in the material?
- **Strength:** How strong is the material?
- **Exposure**: How will the material change with exposure to chemicals?
- **Assembly**: How will the product fail at assembly (bond or fastener)?
- **Packaging:** Is the product protected?

Material (Front End) vs. End Product Testing

Abridged List

Material PP ASTM D4101
ASTM D1238 Flow Rate
ASTM D638 Tensile
ASTM D790 Flexural
ASTM D256 Izod Impact
ASTM D648 Heat Deflection Temp.

Through the VSI Product Certification Program, polypropylene siding manufacturers can certify with verification by an accredited quality control agency that their products meet or exceed the ASTM D7254, the Standard Specification for Polypropylene (PP) Siding.

Product PP siding ASTM D7254
D4101 Conditioning
ASTM D4226 Impact
ASTM G147 Weatherability
ASTM 5206 Windload
ASTM E84 Flamespread

Identification: What is this material?

FTIR, a good 1st response.

Additional Options:

- DSC (Tm & Tg) and/or Ash (% filler)
- Deformulation – High end analytical techniques
- Ex: FTIR scan PET & DSC scan

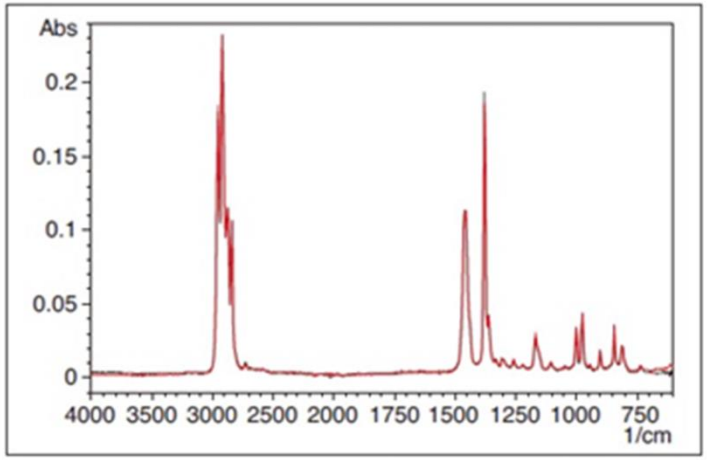
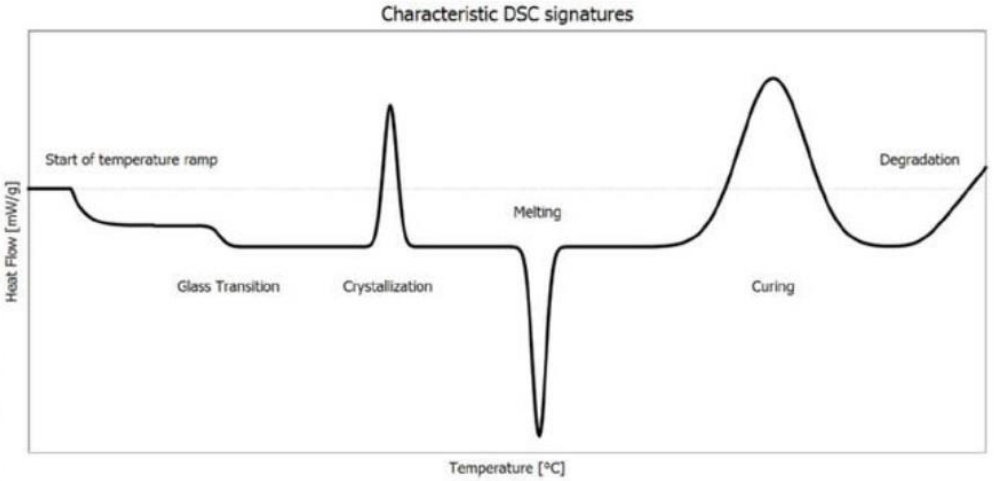


Image: TA Instruments



Identification: Glass Transition Temperature

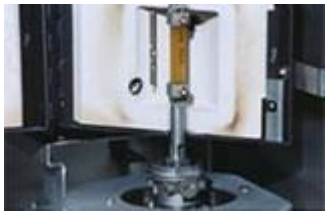
What is the Tg of a material?

- **DSC** – heat flow (common, but may not be sensitive enough)
- **TMA** – mechanical approach
- **DMA** – response to stress/strain

DSC

TMA

DMA



Blog

A Closer Look: Techniques for Obtaining Glass Transition Temperature (Tg) of Polymeric Materials

http://www.intertek.com/blog/2013-04-15-glass-transition-temperature/

Processing: Is there degradation?

Material: Plastic

Why:
Diminished performance of a part

How:
Melt flow index – a common practice.

Resin, “good” and “bad” parts

Alternative options:

- Analytical procedures for understanding MW

Melt flow indexer

Common Practices for MW

MW Analysis Techniques:

- Gel Permeation Chromatography (GPC)
- GPC-UV / RI / SFD / Viscosimetry / ELSD / Light Scattering Detection.
- Multi Angle Laser Light Scattering (MALLS)
- MALDI TOF-MS
- HT- GPC
- GPC-NMR

Molecular Weight Determination (MWD) for Polymers and Plastics:

- Acrylics, Acrylates, Polystyrene, Rubber
- Polycarbonates, Polysiloxanes
- Resins, Epoxy Resins, Polyester Resins, Silicone Fluids
- Prepolymers, Resins, Polyols, Siloxanes

Processing: Are there voids?

Material: Polymer Composites (Laminate)

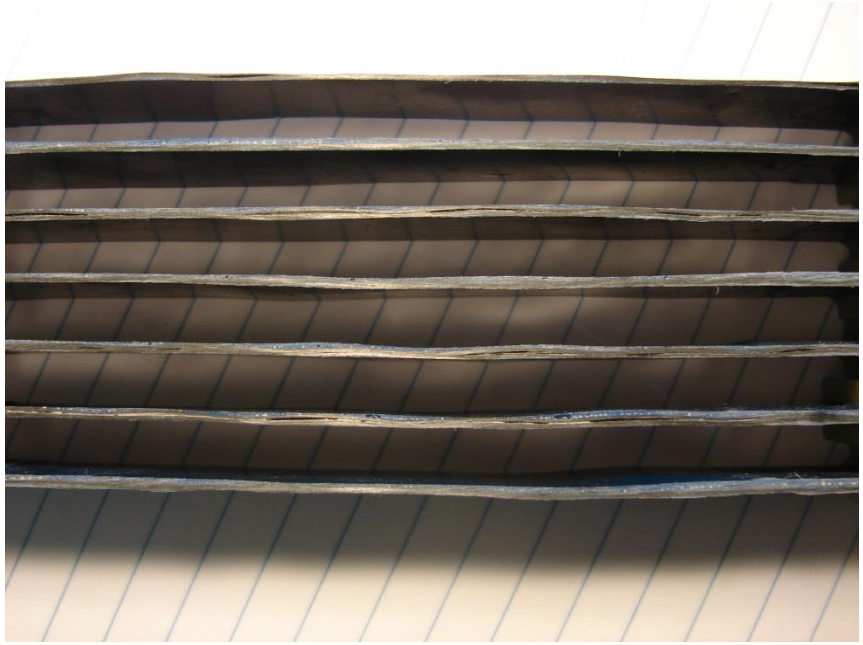
Where:
Applications requiring strength

Why:
Layup process is prone to voids which diminish strength

How:
Void content

Alternative options:

- NDT (non destructive testing)



Voids in composites

Strength: How strong is a material?

Materials: Polymers

Where:
Any application that must withstand force

Why:
Material Characterization

- Tensile (ASTM D638 (plastic), D3039 (composite), D412 (elastomer), D882 (film), ISO 527(plastics, all)
- Compression (ASTM D695, D6641,C365, D3410, ISO 604)
- Flexural (ASTM D790, ISO 178)
- Impact (ASTM D3763, D7192, D7136, ISO 6603)

Additional Options – Full product testing

Mechanical test lab,
Intertek Pittsfield

Tensile & Impact

Quick Reference Guide to Determining Appropriate Tensile Testing Methods for Polymer and Composites Materials ASTM D638 vs ASTM D3039

Grips:

Both ASTM D638 and D3039 require fixed or self aligning, however for ASTM D3039 alignment highly recommended, < 3 to 5% bending considered good testing practice due to the fact that it has been generally shown that over 5% bending decreases ultimate failure strength. Intertek PTL performs ASTM D3039 on a universal testing with state of the art alignment fixture and up to 100 kN capacity.

Extension Indicators:

ASTM D638 uses extensometers exclusively; however D3039 allows for strain gages and more accurate extensometers for more accurate ultimate strength measurement.

- ASTM D638 Extensometers measures Elastic Modulus by ASTM E83 B2; Low extension measurements by Class C or +/- 1% of the indicated value — whichever is better; and for High extension: +/- 10% of the indicated value or better.
- ASTM D3039 Extensometers measures Elastic Modulus by ASTM E83 B1, Transverse Strain: ASTM E83 B1 or A1 for stiff materials. Strain Gage recommendations are 0.250" active gage length, 350 Ohm, ±3%, 1 to 2 V excitation, Linear or Poisson's ratio Rosette. Wire and gage material based on test conditions.

Specimen Types:

- ASTM D638 outlines a variety of specimens for Sheets, Plates, & Molded Plastics- check material specifications!
- ASTM D3039 uses a rectangular cross section with tabbing recommended for unidirectional material.

Conditioning:

- ASTM D638 follows ASTM D618 procedure A and section 7, 40+ hours 23 ± 2°C at 50 ± 10% RH. However, material specification may instruct otherwise.
- For ASTM D3039, ASTM D5229/D5229 M recommended (Standard Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials). However it is not requires if not instructed by requestor. Exposure conditions and moisture content to be reported.

Recommended Test Speeds:

- ASTM D638 is 5 to 500 mm/min (0.2 to 20 in/min) using the lowest speed that ruptures the specimen within ½ to 5 minutes.
- ASTM D3039 is 2 mm/min (0.05 in/min), 0.1 min-1 using the lowest speed that ruptures the specimen within 1 to 10 minutes.

Data report:

- ASTM D638 and ASTM D3039 record load versus extension curves and other data points of interest, however ASTM D3039 also records failure mode.

www.intertek.com/polymers/testing/mechanical/high-speed-impact-testing-video/

How will exposure affect polymer strength?

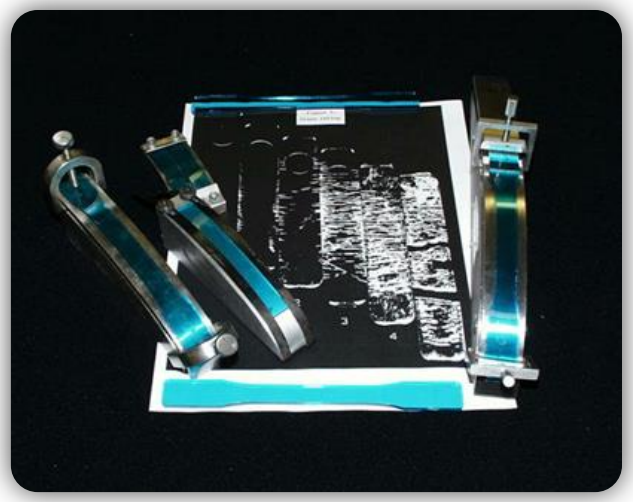
Material: IM building polymer

Material specs:
ASTM *D543 Evaluating the Resistance of Plastics to Chemical Reagents*

Scope:
Injection molded specimens exposed to cleaning solutions

Data:
Visual evaluation and tensile properties

Intertek solution:
ASTM D543 is a guide and allows for variations. Intertek has 25 years' experience developing these programs.



Variables for Chemical Compatibility

Variables	Types of variables			
Test Type	Mechanical	Physical	Visual	Creep
Chemical Exposure	Immersion	Wipe-on	Vapor	Wet Patch
Exposure Conditions	Temp.	Time	# Cycles	
Applied Strain	%	Fixture Type		
Mechanical Tests	Tensile	Flexural	Impact	Shear
Physical Tests	Dimensions	Weight	Hardness	Viscosity
Visual Tests	Unaided	Microscopic	Rating	

Ref: Presented before the ANTEC conference, May 1995 by James Galipeau

Assembly

Material: Plastics & Composites

Where: Products

Why: Optimize assembly for products

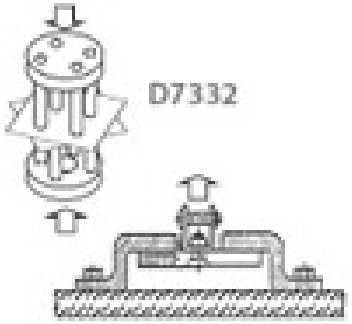
How:

- Fasteners
- Adhesives

Assembly: Fasteners

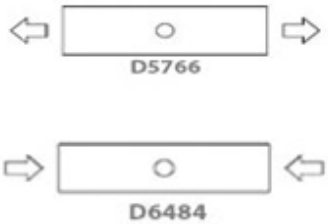
Concerned about a bolt pulling though?

Understand the force required to pull a fastener through a multidirectional reinforced composites laminate using Fastener Pull-Through Test Method (ASTM D7332).



Interested in evaluating failure at the bolt hole?

Understand Failure at the assembly hole by open hole tension (ASTM D5766) or compression (ASTM D6484).



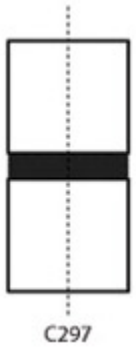
Assembly: Adhesives

How will the adhesive fail?

There are a variety of ASTM single-lap-joint shear tests including (ASTM D1002)

How do I evaluate adhesive failure in a sandwich core construction?

Tensile Strength of Sandwich Constructions (ASTM C297) provides information on core-to-face bonding stability, load transfer along with flatwise tensile strength of sandwich core material.



Packaging

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Will my product be protected?

Case study: Barrier of a flexible sheet material

Equipment	:	MOCON PERMATRAN-W 3/33 MG Plus Permeability Instrument
Test Gas	:	Water Vapor
Test Temperature, ℃	:	5 to 50 ± 0.5
Test Gas Humidity, % RH	:	
Carrier Gas	:	Nitrogen
Gas Flow Rate, SCCM	:	
Side Facing Humidity	:	
Calibration Factor Statement	:	Calibration assigned by the software based on NIST traceable films.
Effective Area Exposed, cm^2	:	50 (Unmasked specimen) or 5 (Masked specimen)
Time to Reach Steady, min.	:	
Description of Conditioning	:	
Significance	:	ASTM F1249 specifies that WVTR and permeability values should be rounded to three significant figures or less.

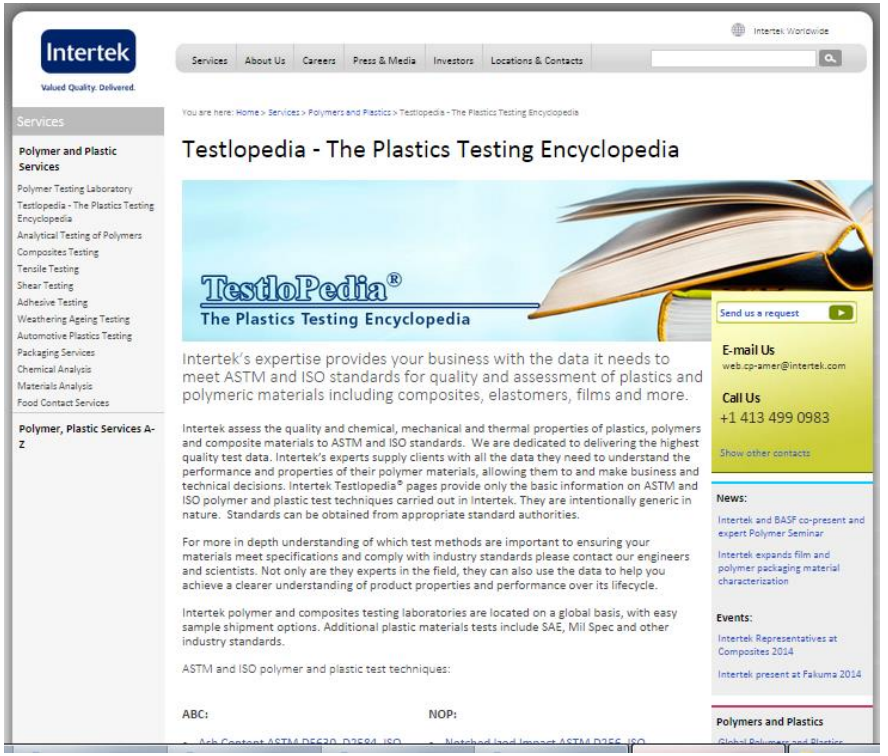
Material Description	:

Test Number	Average Thickness (mm)	Transmission Rate g/(m^2-day)	Transmission Rate g/(100in^2-day)	Permeation Coefficient g-mil/(m^2-day)
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
Average	**0**	**0**	**0**	**0**

Conclusion

Let Intertek know standards and specifications!

- Intertek maintains leadership in ASTM,ISO committees
- Reference: Testlopedia® a free online encyclopedia of polymer tests at www.intertek.com/polymers/testlopedia/



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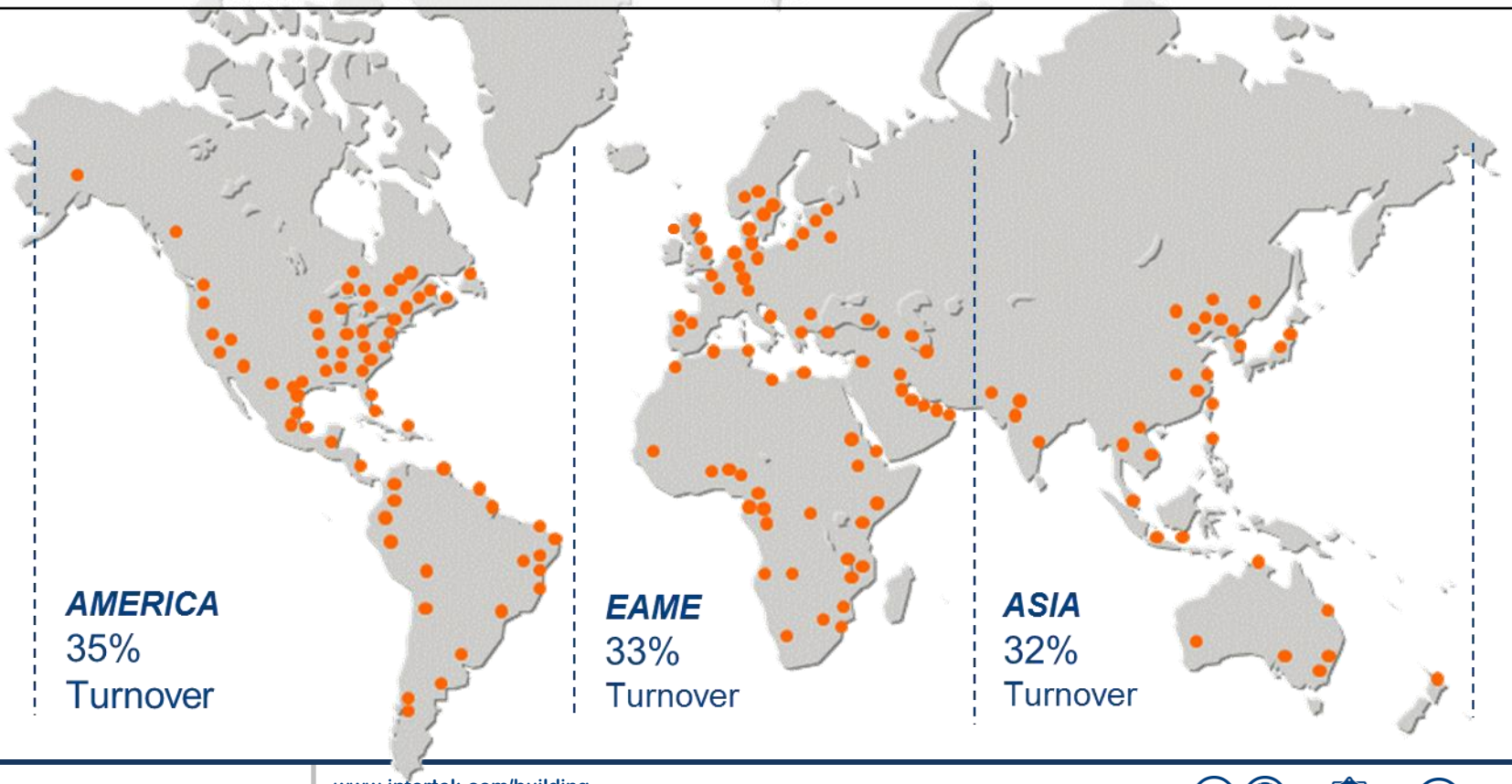
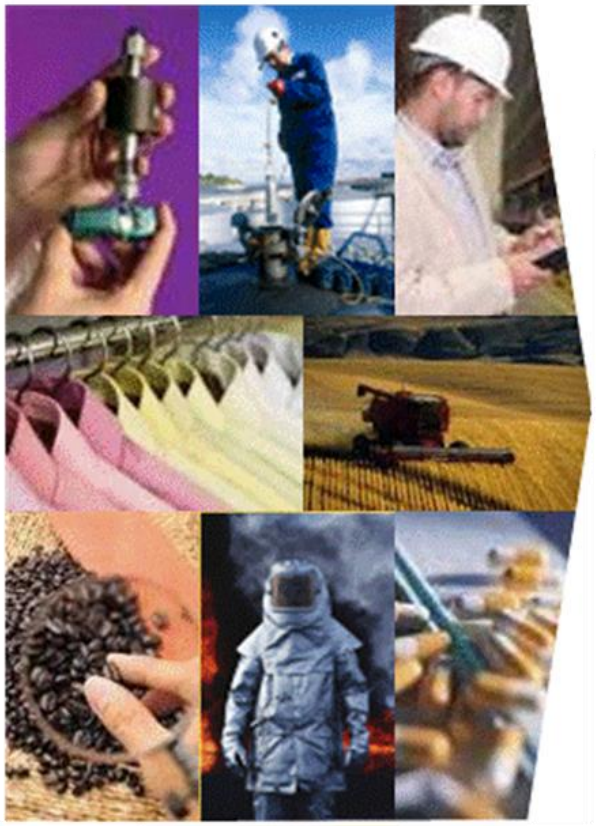


Our Industries

Intertek Architectural Testing

Our organization	Industries we operate in	What we do
Industry Commodities Products		Testing Inspection Certification Auditing Outsourcing Advisory Quality Assurance

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