

Making Sense of Polyolefin Products through Sensory Science

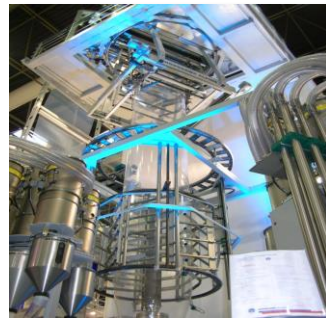
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Sensory Science Leader
The Dow Chemical Company



Capabilities that accurately demonstrate and predict advantages for converters

Fabrication

Cast Film (36" die)	Extrusion Coater (30" die)	5-layer Film (75mm die)	Mono- layer Film (8" die)	7-layer Film (250mm die)	Blow Molding (32oz ½gal mold)	Injection Molding (250 MT die)	Pipe (0.5 – 4" diameter)	Fiber bi-co
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Testing and Scale Up

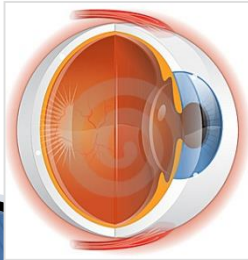
Compounding	Physical Testing	Analytical Testing	Stretch and Highlight	Pipe Testing	VFFS, Multivac	Sensory Science
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Sensory Science

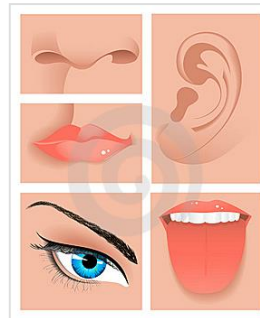
Definition: A scientific discipline used to evoke, measure, analyze and interpret reactions to those characteristics of materials as they are perceived by the senses of sight, smell, taste, touch, and hearing.

Testing of
products for
marketability
using human
senses

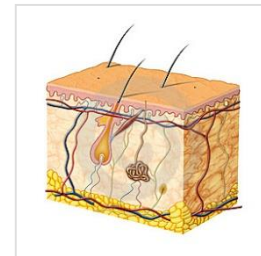
Vision



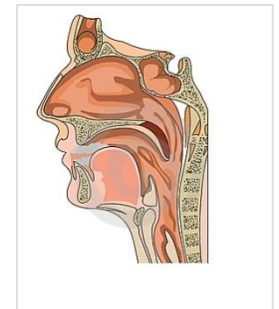
Hearing



Touch



Taste and Smell



Polymer Applications

- ▶ Health & Medical Nonwovens



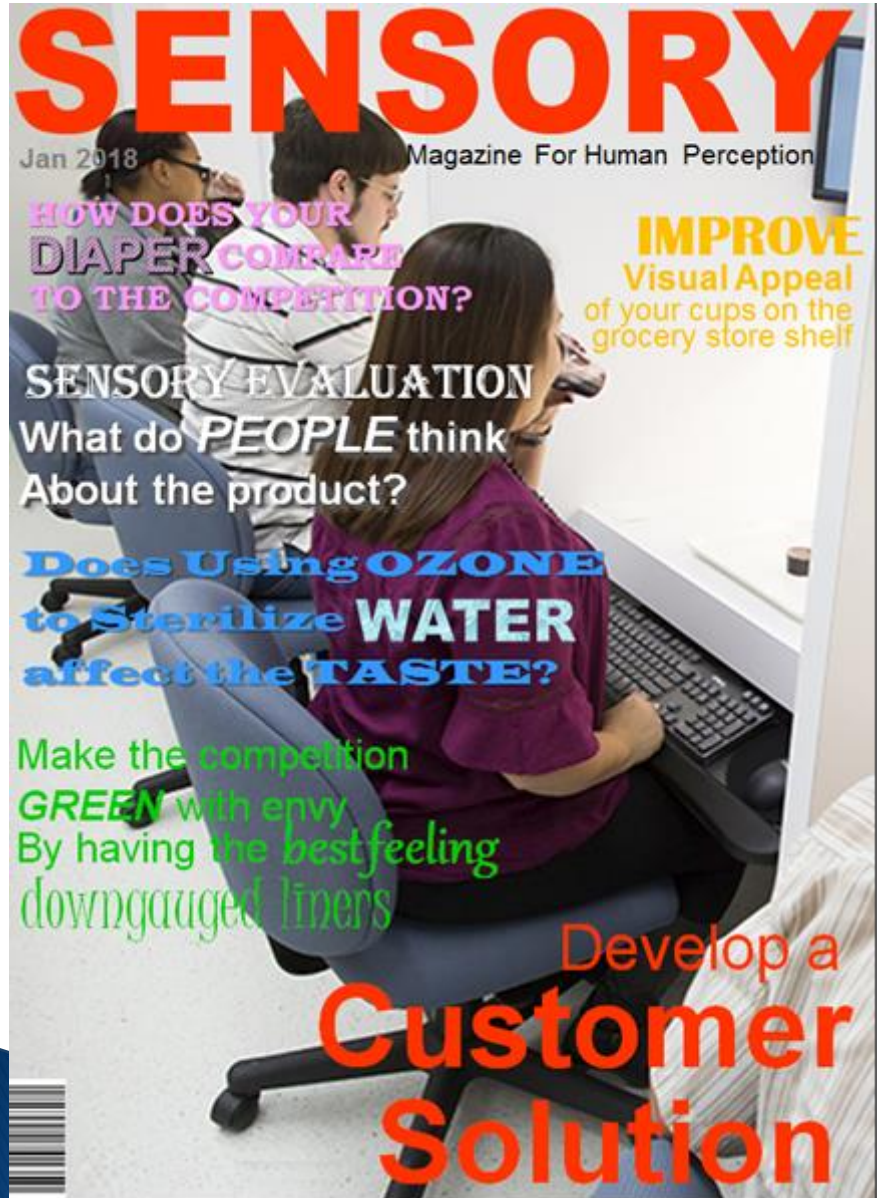
- ▶ Flexible Packaging



- ▶ Rigid Packaging



Purpose



- ▶ Product development
- ▶ Optimization of process conditions
- ▶ Quality assurance
- ▶ Competitive status
- ▶ Customer requests
- ▶ Assist Dow clients in creation of their own sensory analysis

Types of Sensory Panels

- ▶ Trained Panels
- ▶ Untrained / Consumer Panels
- ▶ Descriptive Panels
- ▶ Insight Focus Groups



Sensory Science Studio

- ▶ Odor free environment
 - Carbon filters
 - Positive air pressure
- ▶ Sinks with fragrance-free soap
- ▶ Quiet room to eliminate distractions
- ▶ Soft, neutral colors on walls and cabinets
- ▶ Special lighting
- ▶ Individual booths
- ▶ No odor floor material
- ▶ Separate preparation room



Panelists

- ▶ Do not eat or drink anything other than water 30 – 60 minutes before evaluation.
- ▶ Non-distracting environment. No talking, No cell phones.



- ▶ No fragranced cosmetics or toiletries.
- ▶ Wash hands with unscented soap.
- ▶ Convince to participate – 10 min, when they choose during the two hour duration of the session.

Screen and Train Panelists

Screening

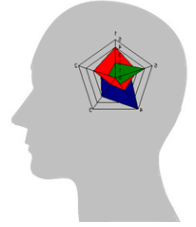
- ▶ 5 basics tastes:
 - Sweet, Salty, Sour, Bitter, Umami
- ▶ Difference tests (Triangle)
- ▶ Ascending concentration (Ranking)
- ▶ Odor recognition (Matching)

Qualified and trained panelists acts as calibrated instrument

Training

- ▶ Common language / Calibrate panel
- ▶ Common characteristics associated with products that will be evaluated.

Scientific Method



- ▶ Follow ASTM Standards
- ▶ Screened and trained panelists
- ▶ Specially designed sensory lab
- ▶ Balanced block design
- ▶ Random three digit blinding codes
- ▶ Large number (n) of assessors
- ▶ Statistical analysis
- ▶ Human Studies Review Board



Difference Tests

Two Samples

- ▶ Paired Comparison: Which is least in a given attribute?
 - Straight Forward, $p = \frac{1}{2}$, One or two-tailed table
- ▶ Duo-Trio: Which is the same as the Reference?
 - Good if there is a Reference, $p = \frac{1}{2}$, One-tailed table
- ▶ Triangle: Which is different than the other two?
 - Common w/Consumers, $p = \frac{1}{3}$, One-tailed table
- ▶ Two-out-of-Five: Which two are different than the other three?
 - Similar to Triangle, $p = \frac{1}{10}$, two-out-of-five table

A B

Ref: A B

A B A

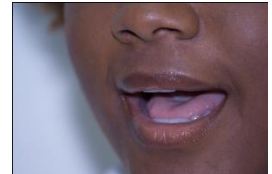
A B A B A

Three or More Samples

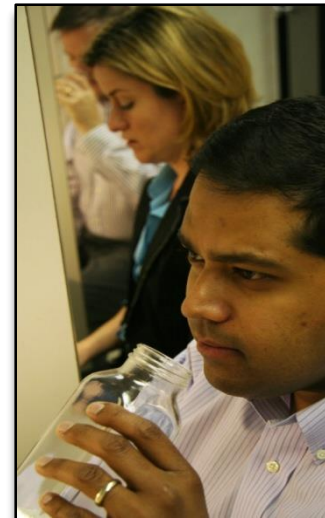
- ▶ Ranking: Put the sample in order from least to most intense.
 - ANOVA then a multiple comparison such as Friedman or Duncan Analysis

A B C

Taste and/or Odor



- ▶ Organoleptic, adj. – relating to a property of a sample received by the sense organs (obsolete, see sensory) – 2001
- ▶ Sensory, adj. – pertaining to the sensory organs



Packaging and Food Interactions



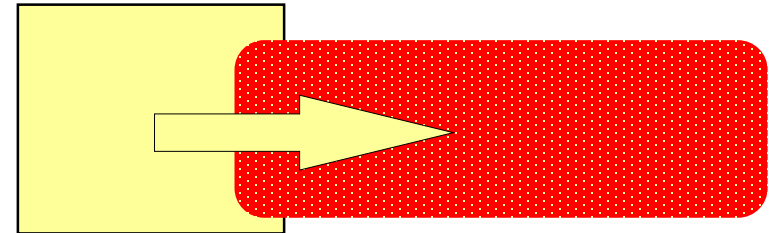
POLYMER

PACKAGE

FOOD

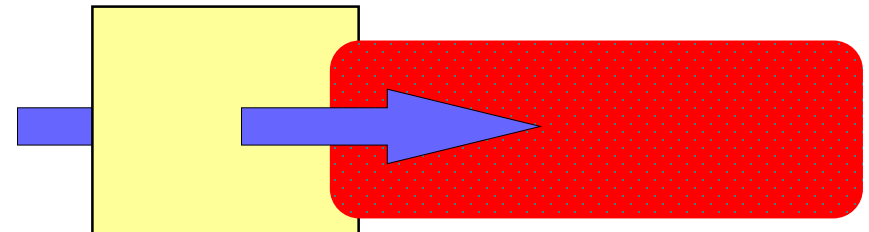
▶ Contribution

- Migration of taste/odor into food



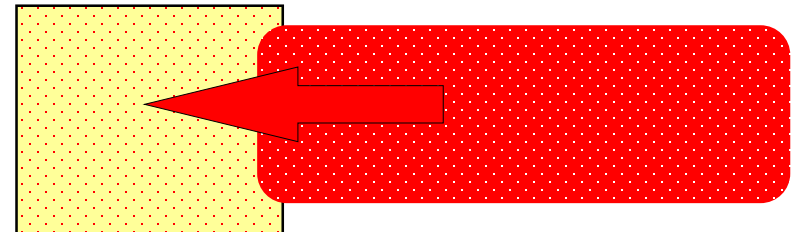
▶ Permeation

- Taste/odor through packaging into food



▶ Absorption/Scalping

- Migration of flavors out of food into packaging



Preparation of Samples



- ▶ Prep samples as close to the end application as possible.
- ▶ Same surface area to volume ratio and temperature conditioning.
- ▶ Food media for taste tests:
 - Water is neutral and will not mask taste from polymer packaging.
 - Water quality must have a 'neutral' taste to the participating panelists.
 - End-use food will provide contribution and scalping effect results.

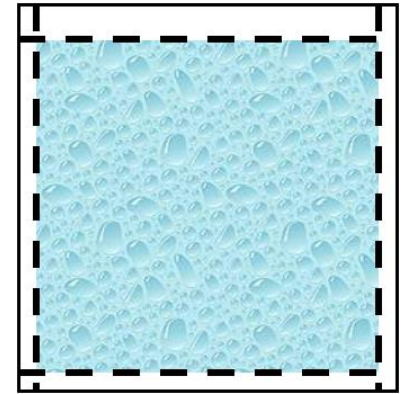
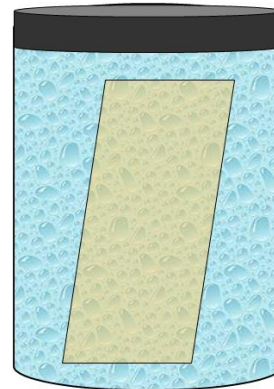


Preparation cont.



Taste

- ▶ Co-extruded, laminated, extrusion coating:
 - make a pouch, fill with water
- ▶ Monolayer or pellets:
 - Immerse film into glass Jar of water with foil or PTFE lined lid



Odor

- ▶ Put polymer into glass jars
- ▶ All samples should look identical.

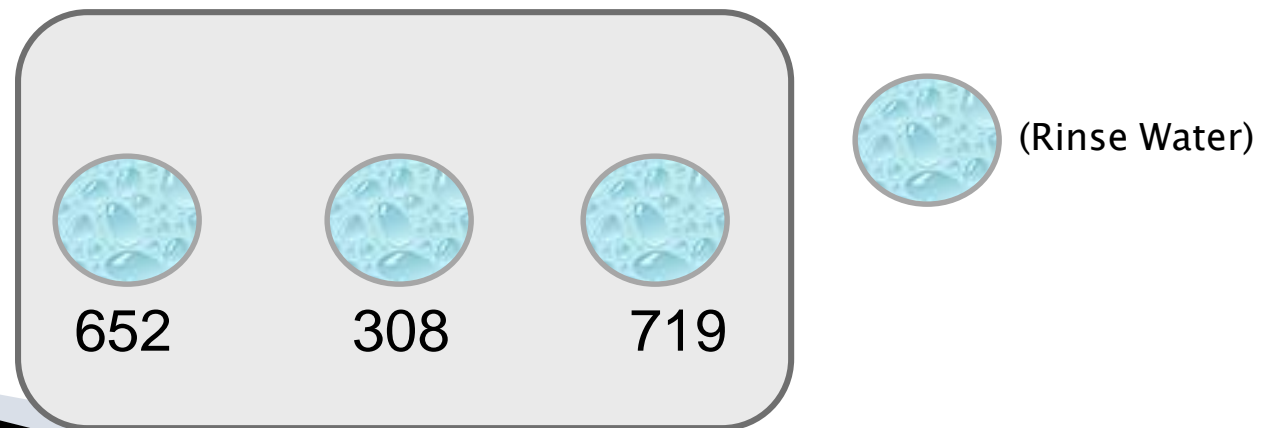


Sample Presentation

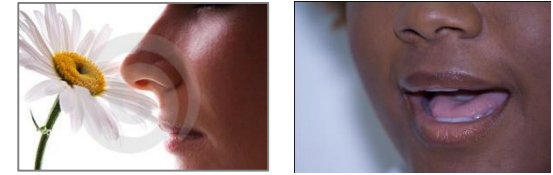
- ▶ 3-digit coded samples
- ▶ Balanced Block Design

Sample A = 652
Sample B = 308
Sample C = 719

Panelist 1: A B C
Panelist 2: A C B
Panelist 3: B C A
Panelist 4: B A C
Panelist 5: C B A
Panelist 6: C A B



Example of a Ballot



1) Odor Intensity Difference Evaluation:

Rank from Least To Most Intense.

Least _____

Most _____

2) Hedonic Acceptability Rating:

Dislike extremely	Dislike very much	Dislike moderate	Dislike slightly	Neither like /nor dislike	Like slightly	Like moderate	Like very much	Like extremely
1	2	3	4	5	6	7	8	9

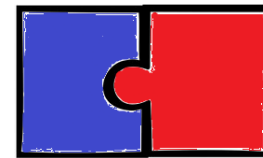
3) Descriptive Analysis:

Characteristic of sample 652 is: _____

Characteristic of sample 308 is: _____

Characteristic of sample 719 is: _____

Instrument Correlation

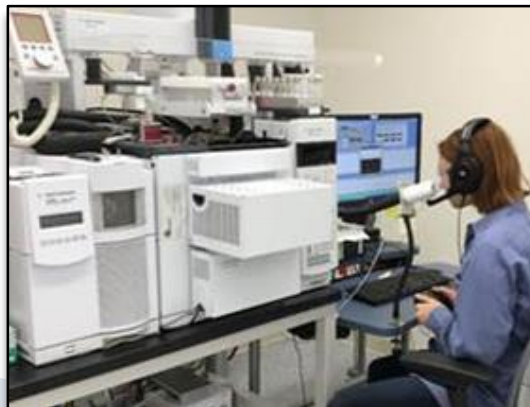


▶ Human

- More sensitive / very low threshold (ppb vs. ppm)
- Determine acceptability

▶ Instrument

- SPME/GC/ODP/MSD (GC/sniff port):
Isolation & Identification of off-taste/odor causing components
- E-Nose: Quality assurance; within specification



Haptics / Handfeel



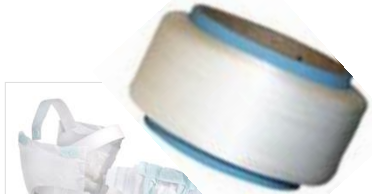
- ▶ Handfeel, adj – of or relating to or proceeding from the sense of touch.
- ▶ Haptics, adj of or relating to or proceeding from the sense of touch as related to tactile muscle movement.



Handfeel Applications



- Imitation leather
- “Soft touch” film packaging
- Fibers
- Non-woven
 - Medical garments
 - Personal hygiene
 - Adult Incontinence
- “Soft touch” molded parts
 - Shoe soles
 - Cases
- Coatings



Handfeel Attributes



- ▶ Stiffness
- ▶ Fuzziness
- ▶ Tensile stretch
- ▶ Grainy



- ▶ Waxy
- ▶ Cotton
- ▶ Smoothness
- ▶ Thermal
- ▶ Force to gather
- ▶ Friction
- ▶ Softness (smoothness, stiffness, thickness and compression)

Trained
Panel
evaluates
individual
attributes

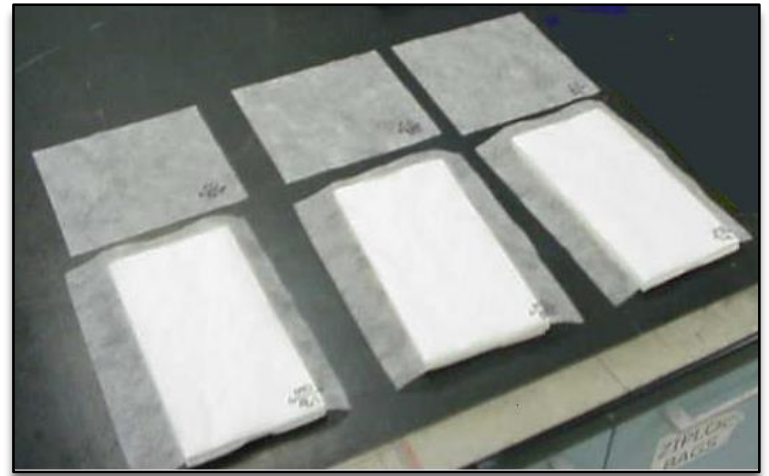
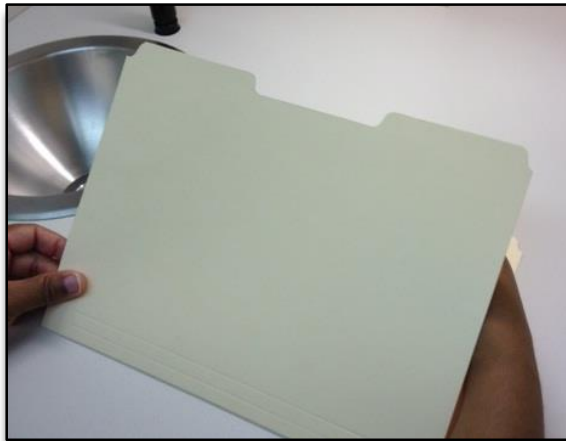
list not all-inclusive

A trained handfeel panel, in contrast to a consumer panel, has the ability to evaluate one attribute at a time, rather than be overwhelmed by all the characteristics of the material at once. They have the capability to determine differences between samples with very small differences and have been trained on the various handfeel techniques required for reliable, reproducible data.

Handfeel Preparation



- ▶ Prep samples as close to the end application as possible.
- ▶ All samples should look identical.



Ballot

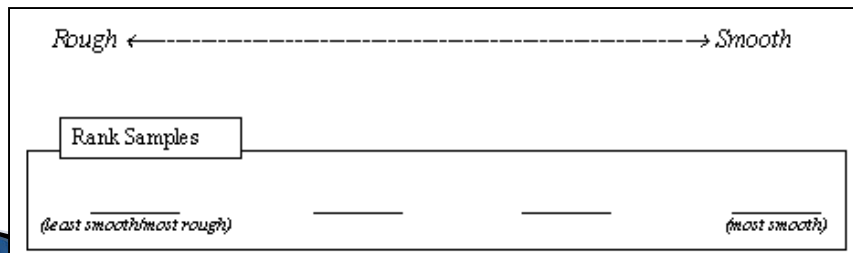


Attribute: *Smoothness*

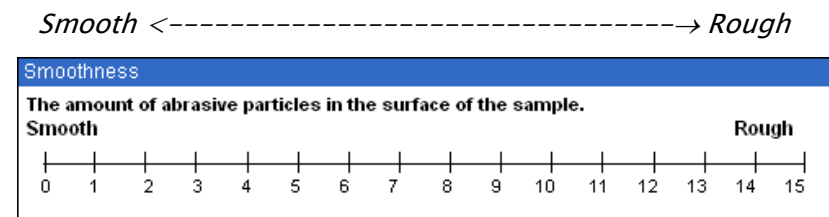
Technique: *Lay the sample flat on the table; evaluation side up. Place heel of hand on the table top; Move fingers along the surface of the samples.*

Description: *Evaluate for the amount of abrasive particles on the surface of the sample.*

Ranking example:



Rating example:

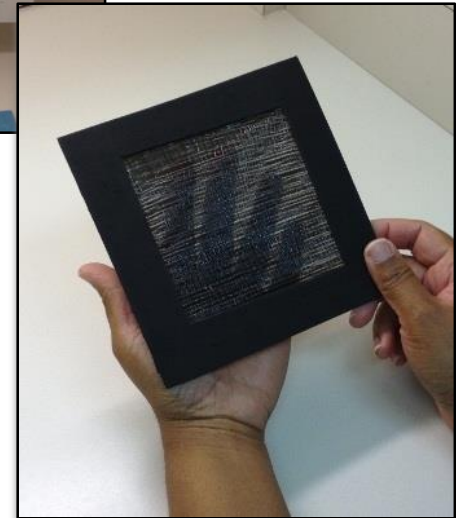
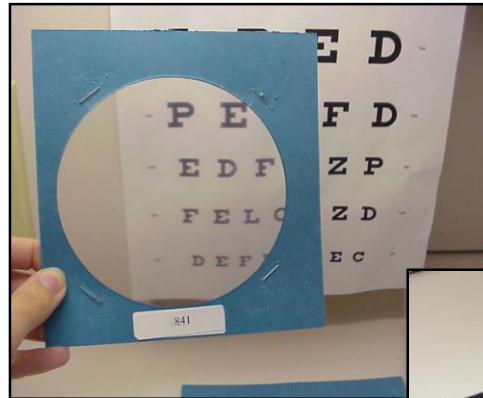


Visual Attributes



- ▶ Contact Clarity
- ▶ Distance Clarity
- ▶ Gloss / Matte
- ▶ Color match
- ▶ Softness
- ▶ Preference

list not all-inclusive



Auditory Attributes



- ▶ Noise intensity
- ▶ Noise pitch



list not all inclusive

Motivation



- ▶ Immediate feedback
- ▶ Management support
- ▶ Reward



*A system for
maintaining panel
interest and morale is
critical to continued
participation and
performance of panel
members and
ultimately the
success of the
sensory program.*
-ASTM STP 758

Performance Plastics
Sensory Science Lab

Panelist of the Month

Outstanding Participation
October 2012

John Doe

Case Study: Functional Coating with Enhanced Optics and Haptics for Flexible Packaging

What is the consumer preferences of Matte packaging?

- ▶ Appeal of package
- ▶ Package tells the story about the product
- ▶ Differentiate with perception of high quality
- ▶ Matte appearance is being associated with more natural

New Matte Coating–Formulation

Formulation Components
Acrylic Beads
Acrylic Binder
Additives

Product Properties	Result
Viscosity (Brookfield, 25°C, mPa.s)	300 \pm 150
pH	8.5 \pm 0.5
Solid %	32 \pm 2
Appearance	White Milky

Soft Matte Coating

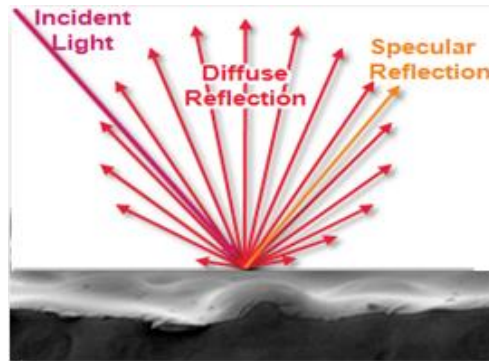
▶ Matte Appearance

Low reflection

Print richness

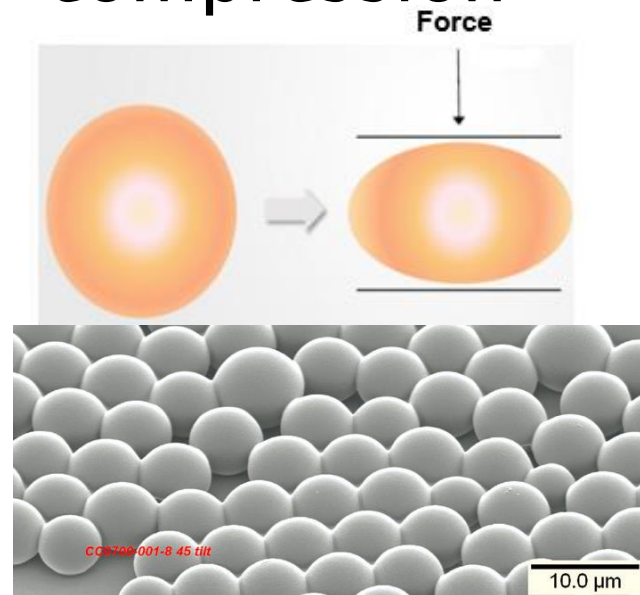
Brighter and deeper

Color



▶ Soft Touch

Acrylic bead polymer absorbs impact under compression



Samples

▶ Pet Food

Block bottom
side-gusseted
bags



Spot | Gloss | Matte



▶ Snack Food

Stand-up pouch

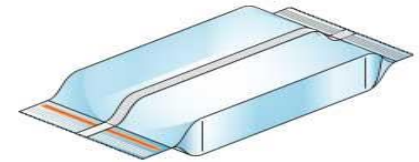


Spot | Gloss | Matte



▶ Health Bar

Pillow pouch
with fin seal



Gloss | Spot | Matte



Sensory Panel – Haptics and Visual

Visual Softness

The perceived softness of the packaging by only looking at it.

Technique: Do Not touch the samples. Visually examine the samples, you may stand up and move around to view from all angles.

Scale: Least Soft ↔ Softest

Tactile Softness

The perceived softness of the packaging when touching it.

Technique: Pick up the sample and hold it, as if taking off of the store shelf. Mover your fingers along the surface.

Scale: Least Soft ↔ Softest

Premium

Evaluate for the degree of premium characteristic of this product.

Technique: Consider all the attributes and determine the level of High Quality.

Scale: Least Premium ↔ Most Premium

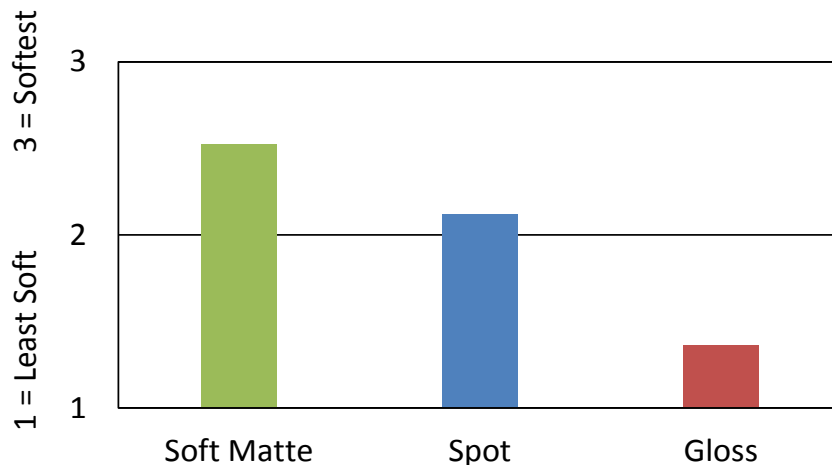
Visual Analysis of Snack Food



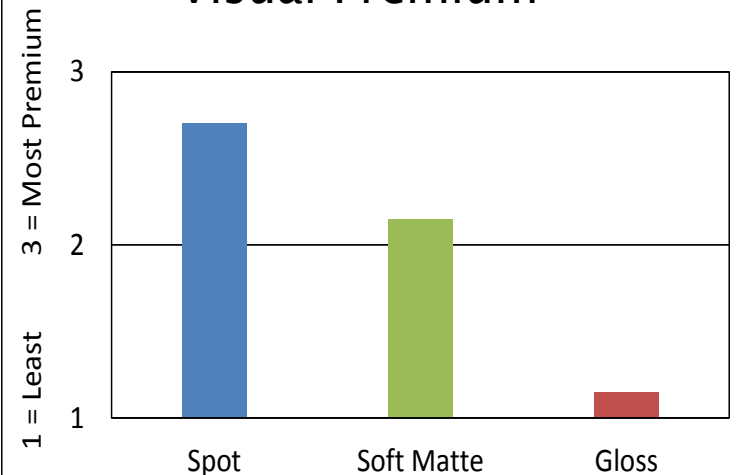
Matte visually seems softest

Spot has striking contrasts and draws eye in

Visual Softness



Visual Premium



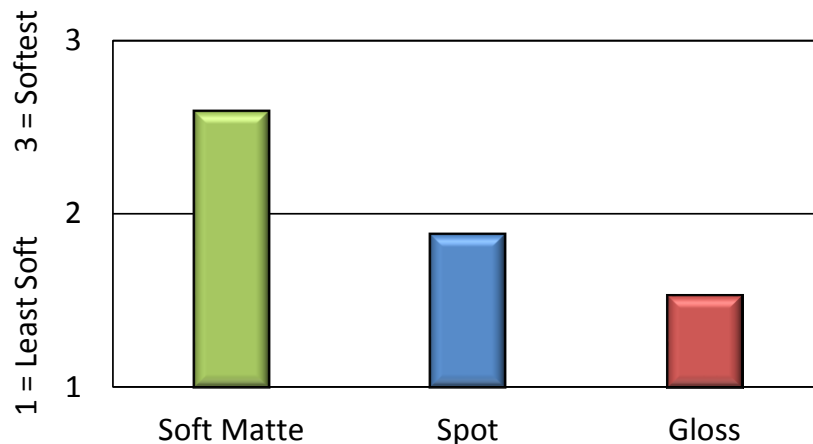
Haptics Analysis of Snack Food



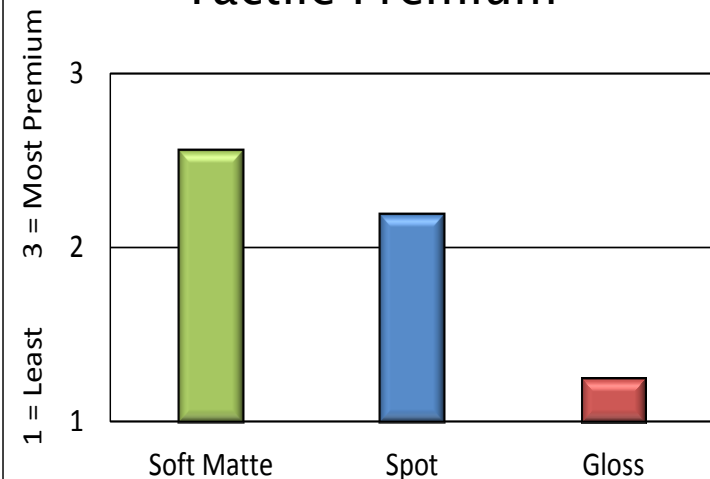
Matte is softest to the touch

Matte and Spot are perceived as higher quality

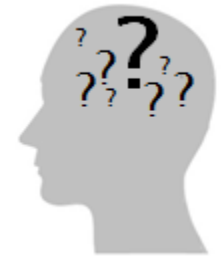
Tactile Softness



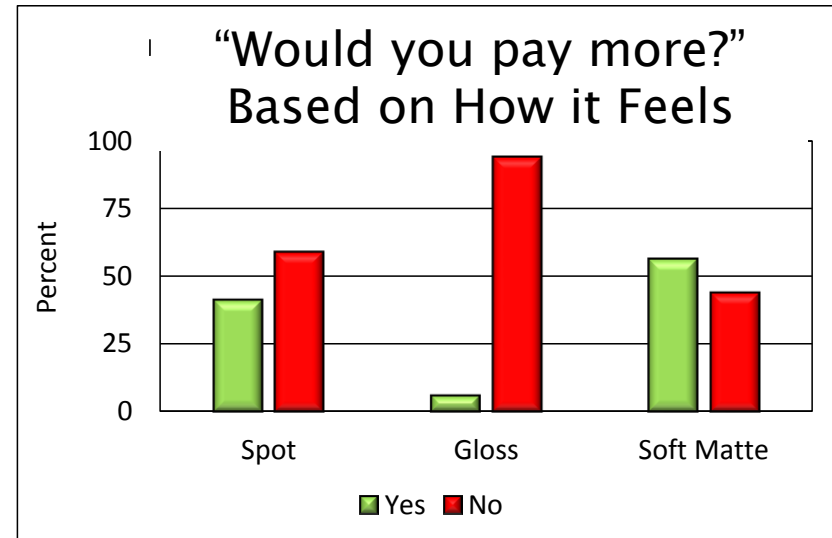
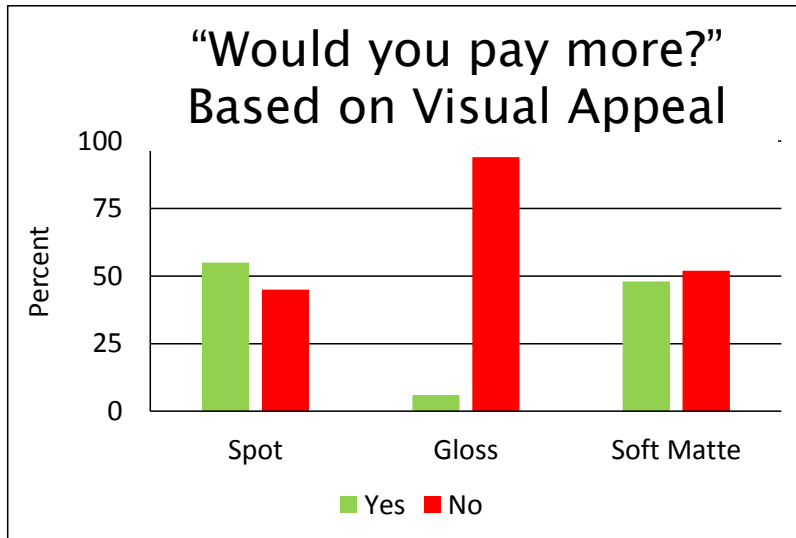
Tactile Premium



Soft Matte–Effect on Consumer Behavior

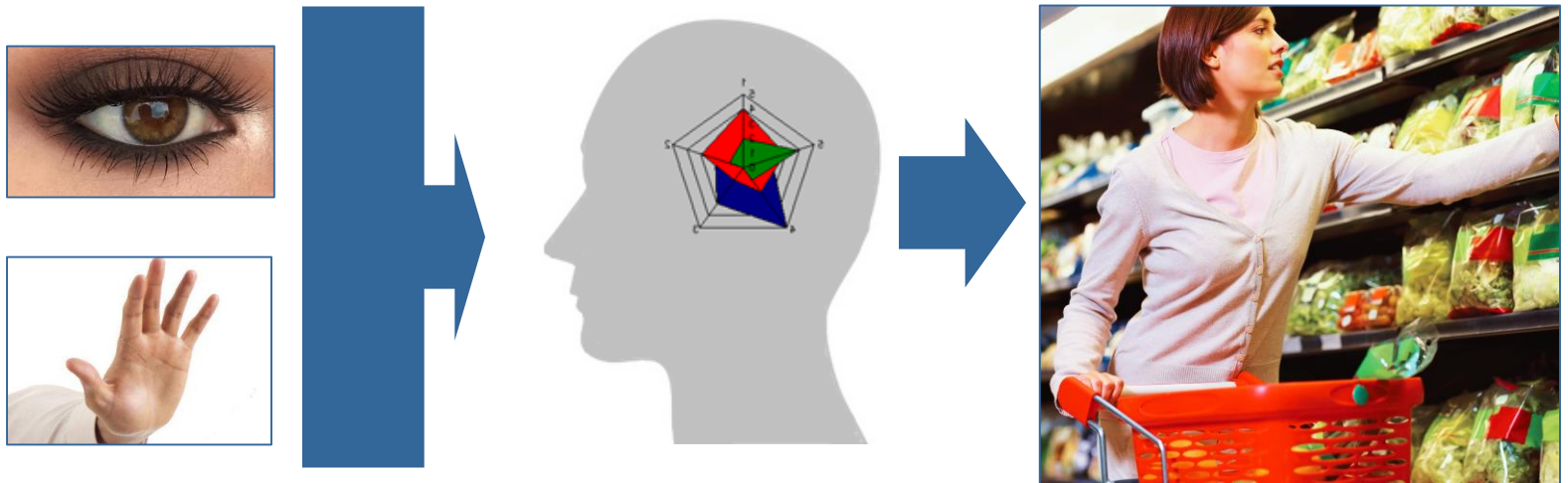


Matte and Spot indicate an improvement in purchasing power compared to Gloss



Case Study Conclusion

The new matte finish, water-borne acrylic emulsion technology, is suitable to provide superior matting, soft touch and enable the brand owners to differentiate their flexible packaging.



Conclusion

- ▶ To measure what consumers think about your product, you need human input.
- ▶ Sensory science can help
 - Identify how packaging affects the taste of food
 - Determine the different odor characteristics of polymers
 - Evaluate how something feels which influences consumer perceptions
 - Improve visual appeal of your product on the store shelf
 - Help understand cultural difference of acceptance
- ▶ Sensory science can deliver customer solutions.

References

1. Meilgaard, Morten, Civille, Vance, G., and Carr, B. T., *Sensory Evaluation Techniques*, 2nd Edition, CRC Press, Boca Raton, FL, 1991.
2. O'Mahony, M., *Sensory Evaluation of Food: Statistical Methods and Procedures*, Marcel Dekker, New York, NY, 1986.
3. Jellinek, Gisela, *Sensory Evaluation of Food: Theory and practice*, VCH Verlagsgesellschaft; Chichester: Horwood, 1985.
4. Stone, H. and Sidel, J.L., *Sensory Evaluation Practices*, Academic Press, Inc, Orlando, FL, 1992.
5. ASTM MNL 26 Sensory Testing Methods
6. ASTM STP 758 Guidelines for the Selection and Training of Sensory Panel Members
7. ASTM MNL 13 Manual on Descriptive Analysis Testing for sensory evaluation
8. ASTM DS72 Lexicon for Sensory Evaluation: Aroma, Flavor, Texture, and Appearance
9. ASTM E2164 Test Method for Directional Difference Test (paired comparison)
10. ASTM E1885 Test Method for Sensory Analysis - Triangle Test
11. ASTM E2610 Test Method for Sensory Analysis - Duo-trio
12. ISO 8587:1988- Sensory Analysis – Methodology – Ranking.
13. ASTM E1870 Standard Test Method for Odor and Taste Transfer from Polymeric Packaging Film
14. ASTM E1609 Standard Test Method for Odor or Flavor or Both from Polymeric Rigid Polymeric Packaging

Making Sense of Polyolefin Products through Sensory Science

Thank you

PRESENTED BY

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