MINN Pack

CenterStage

# Breakthroughs in Intelligent & Responsive Packaging to Reduce Food Waste

Packaging Technology and Research

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MICHIGAN STATE

OVERVIEW

About Me

Role of Intelligent Food Packaging

End Game

EXISTING SOLUTIONS

BREAK THROUGHS

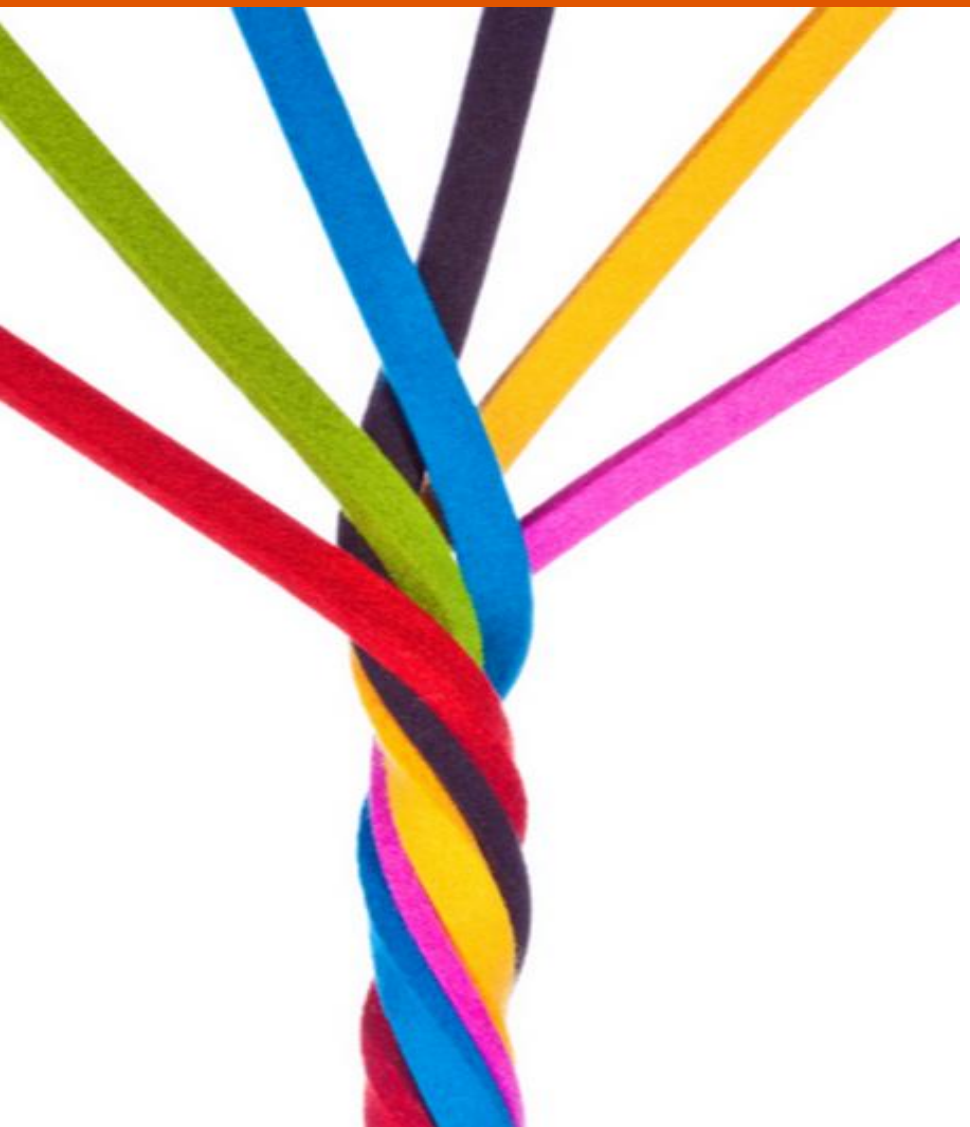
KEY TAKEAWAYS

# Overview: Role of Intelligent Food Packaging

- **Measure and communicate to different entities in the value chain**
- **Food waste, fraud and marketing**
  - Current intelligent packaging solutions
  - Breakthroughs

# Overview: Role of Intelligent Food Packaging

# Overview: End Game



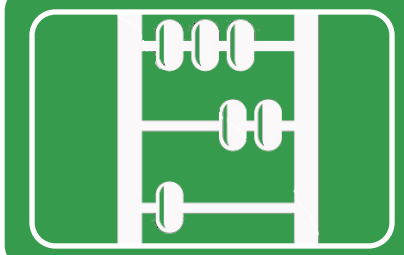
**We need to *twist* success of intelligent packaging in fraud detection and marketing to *better* address intelligent packaging solutions to food waste**

| | | | |
|---|---|---|---|
| OVERVIEW | About Me | Role of Intelligent Food Packaging | End Game |
| EXISTING SOLUTIONS | TTI’s | Degradation sensors & Fraud alerts | Communication Sensors |
| BREAK THROUGHS | | | |
| KEY TAKEAWAYS | | | |

# Existing Solutions: Intelligent Packaging Solutions

## Food Waste

- TTis
- Degradation Sensors



## Fraud

- Overt
- Covert

## Marketing

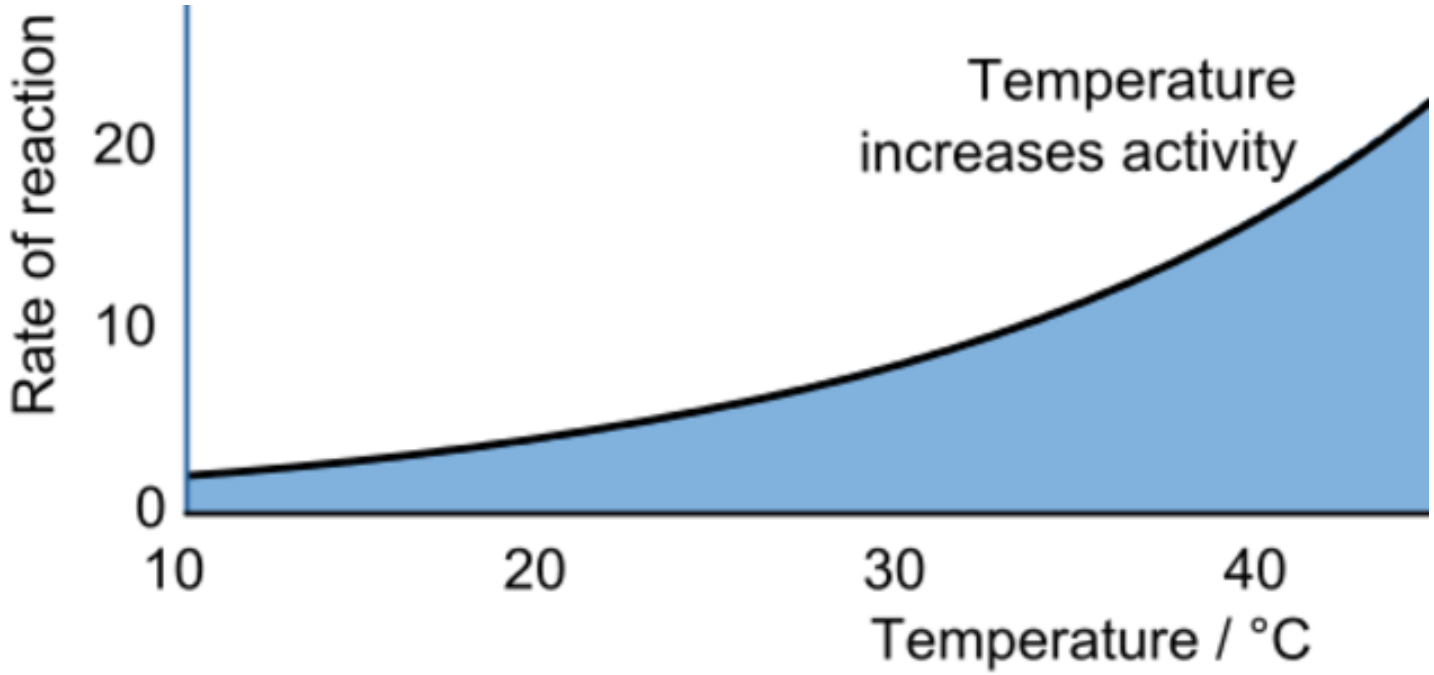
- Communication Sensors

# Existing Solutions: Food Waste - TTI's

## TTIs are a refined proven technology

- Remain relevant since temperature governs reaction rates and controls microbial growth

$$k = Ae^{-E_a/(RT)}$$



# Existing Solutions: Food Waste - TTI's (cont)

## TTIs solutions are plentiful

- *FreshCode,* Varcode and *Tempix*, Tempix
  - fading barcodes



- *CoolVu*
  - aluminum layer thins causing a reaction


- *FreshMeter*
  - turns from blue to gray via benzopyridine photoactivation


- *L5-8 Smart Seafood*
  - irreversible color change from the hydrolysis of triglycerides

# Existing Solutions: Food Waste - Degradation Sensors

**Degradation sensors are advancing**

❖Direct connection to food deterioration

Current solutions

- Measures total volatile basic nitrogen (TVBN)
- Monitors cysteine loss via hydrogen sulfide
- $CO_2$ sensors indicate freshness loss as produce respires
- Color change indicator that activates as microbial growth increases

# Existing Solutions: Food Fraud - Overt

**Overt authenticity is refined and solutions exist**

❖**Overt** acts as deterrent and prevention

Current solutions

- Fiber tear
- TE bands
- *Timestrip* and *Novas* - time elapsed since opening
- RFID and NFC
- Alien Technology, CAENRFID, Convergence Systems
- *authentiQ*, *Sicpa*, and *VerifyMe*

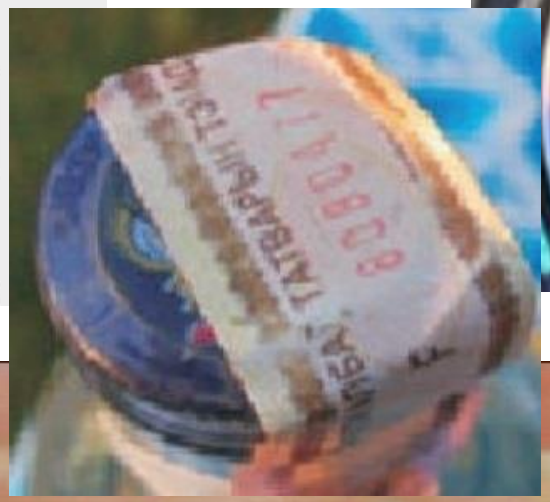
Past solutions

- Fiber tear
- TE bands

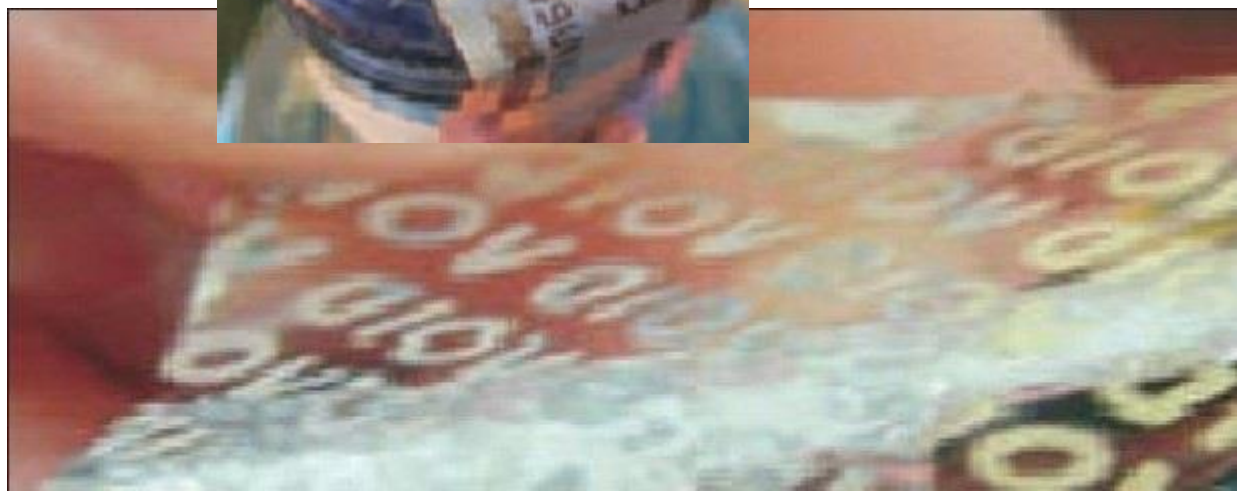
# Existing Solutions: Food Fraud – Overt (cont)

**Overt authenticity is refined and solutions exist**









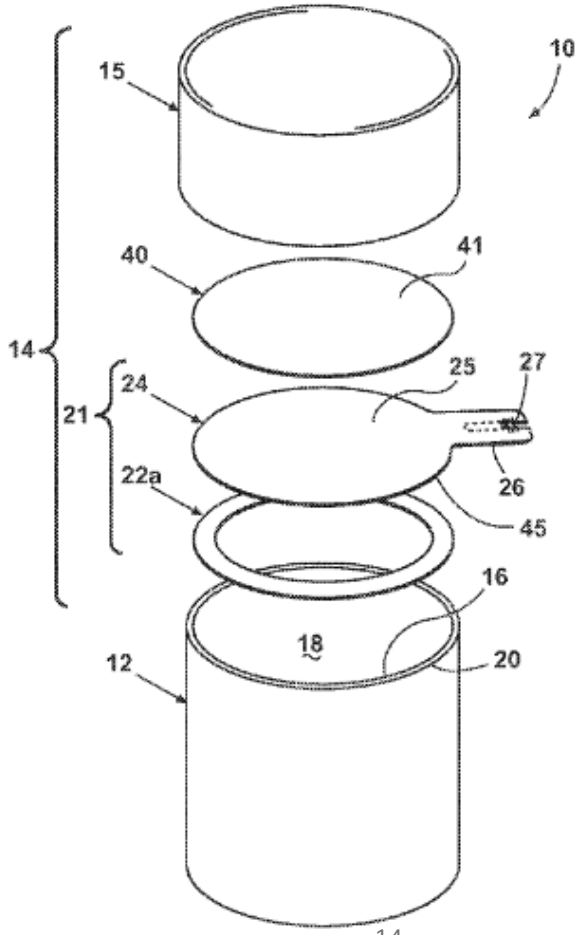
# Existing Solutions: Food Fraud - Covert

**Covert authenticity is refined and numerous solutions exist**

❖Covert is less of a deterrent and more of detection

- Current solutions
  - *FluxSecure* - glass coated metal thread embedded in polymer layers, corrugated cases, and folding cartons
  - TruTag, Flint Group, Spectra Systems - silicon dioxide based tags
  - *SigNature* - printing of plant based DNA to encode barcodes, watermarks, and microdots
  - *Genome Trakr* - DNA based verification methods
  - Alpvision - fingerprint within molded caps and bottles
  - *Unisecure* - imperfection tracking with a 5-megapixel smart phone

# Existing Solutions: Food Fraud – Covert (cont)



# Existing Solutions: Intelligent Marketing

**Intelligent packaging enlarges brand image**

❖Direct connection possible at retail and in-home to enhance brand image

Current solutions

- Thermochromatic inks change color and reveal images when the product is at the proper temperature to eat or drink
- NFC *OpenSense* package sensor is tapped with a smartphone
- Polymark fluorescence based detection for sorting food-contact PET

# Existing Solutions: Intelligent Marketing (cont)

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| KEY TAKEAWAYS | | | |

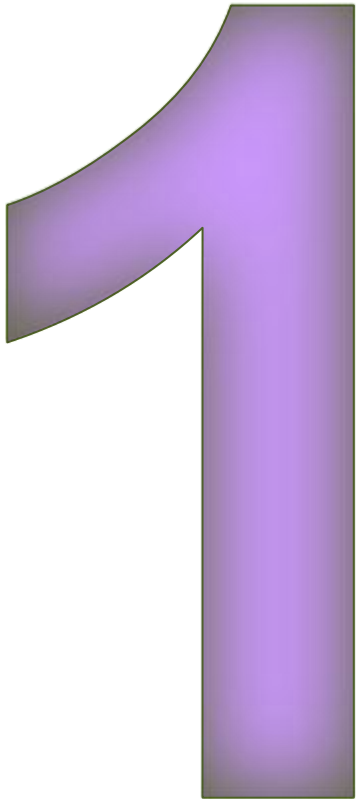
# Breakthroughs: Food Waste

**TTIs needs applied research**

- Degradation sensors – advanced materials research needed to link deteriorative reactions to action

- Applied research is needed to decrease food waste and lower costs
  - Develop for in-home use by consumers before and after package is opened
  - Development of multiple use TTIs
  - Seamless integration into packaging
    - Label
    - Seals

# Breakthroughs: Food Waste (cont)

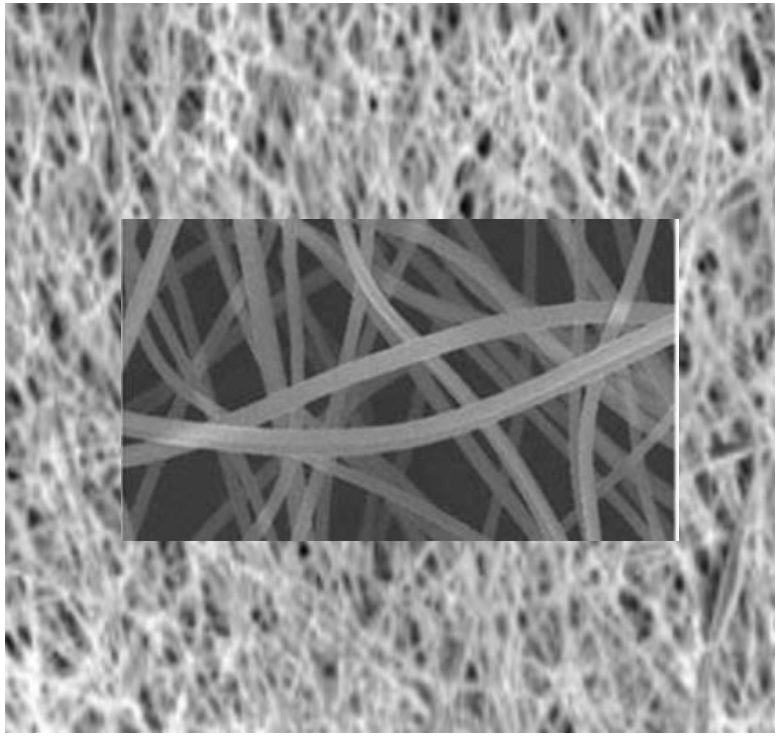


**Applied material science for seamless integration of degradation sensors into packaging**

# Breakthroughs: Food Waste (cont)

**Applied material science for seamless integration of degradation sensors into packaging**

- High surface to volume ratio of nanofibrous membranes and electrospun sensors
- Graphene printing and conductive polymers
- Incorporate antibodies (for detection) within polymer films



# Breakthroughs: Food Waste (cont)

**Simple communication with entire value chain**

# Breakthroughs : Food Waste (cont)

**Simple communication with entire value chain**

- More sophisticated sensors that convert biochemical signals to electrical responses
  - Show remaining shelf life
  - From manufacturer to consumer

# Breakthroughs : Food Waste (cont)

**Detect then act**

# Breakthroughs : Food Waste (cont)

**Detect then act**

- Responsive sensors that detect then act to reduce deteriorative reactions
  - Through the release of $CO_2$, antioxidants or pH change agents

# Breakthroughs : Fraud Research

**Need to reduce fraud is high:**

# $62 5

**billion industry by 2020**

Food and packaging fraud are intertwined from ingredients to finished goods

# Breakthroughs: Fraud Research (cont)

## RPET vs PET discernable by DSC

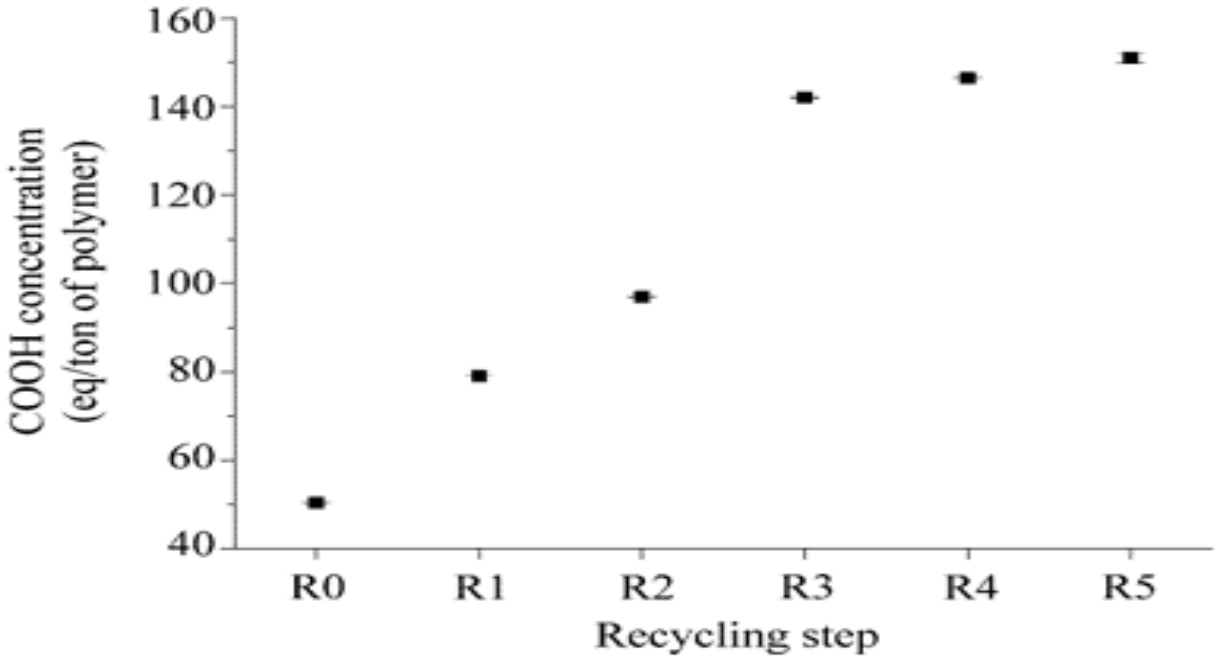



**Figure 2.** Carboxylic end group concentrations of PET samples starting from virgin resin as a function of the recycling step.

- Understand that packaging fraud is economically driven
  - Replace RPET with PET as prices fluctuate
  - RPET COC unsteady
  - RPET demand exceeds supply

# Breakthroughs : Fraud Research (cont)

**Covert and overt anti-fraud research on packaging fraud is needed**

- Detection of contamination is an advanced area of research
- Focus on deterring and early mitigation is needed with a connection to consumers to add value to non-counterfeit packaging
- Focus on role of packaging in predictive and mitigation solutions is needed

# Breakthroughs : Marketing

## Intelligent packaging for marketing needs applied research

- Intelligent packaging – applied research needed to link communication to desired effect
- *Embodied cognition*
- Information in the form of ultra-variable packaging,
- Enable ease of smart device communication to packaging at retail and in the home

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| KEY TAKEAWAYS | Science & Modeling | Leveraged Research | Value Chain | Concerted Focus |

# Key Takeaways: Science & Modeling

**Intelligent packaging for reducing food waste requires deep research in material science and reaction rate modeling**

- Breakthroughs focus on tracking by-products of degradative reactions
- Consumers deserve more than a “sniff test” at home

# Key Takeaways: Leveraged Research

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**Intelligent packaging solutions developed for food fraud and marketing can be readily twisted to reduce food waste**

- Breakthroughs seamlessly integrate intelligent sensors into packaging
- Breakthroughs adapt overt and covert technologies as food deterioration sensors

# Key Takeaways: Value Chain

**Balanced and multifaceted research is needed to encompass the entire value chain and drive research**

- Breakthroughs in research consortiums with input from entire value chain fund research vs one entity in the supply chain
- Breakthroughs focus on reducing food waste and increase savings from:
  - CPGs to consumers
  - Farms to retailers
- Breakthroughs in intelligent packaging connect to consumer derived waste reduction

# Key Takeaways: Concerted Focus

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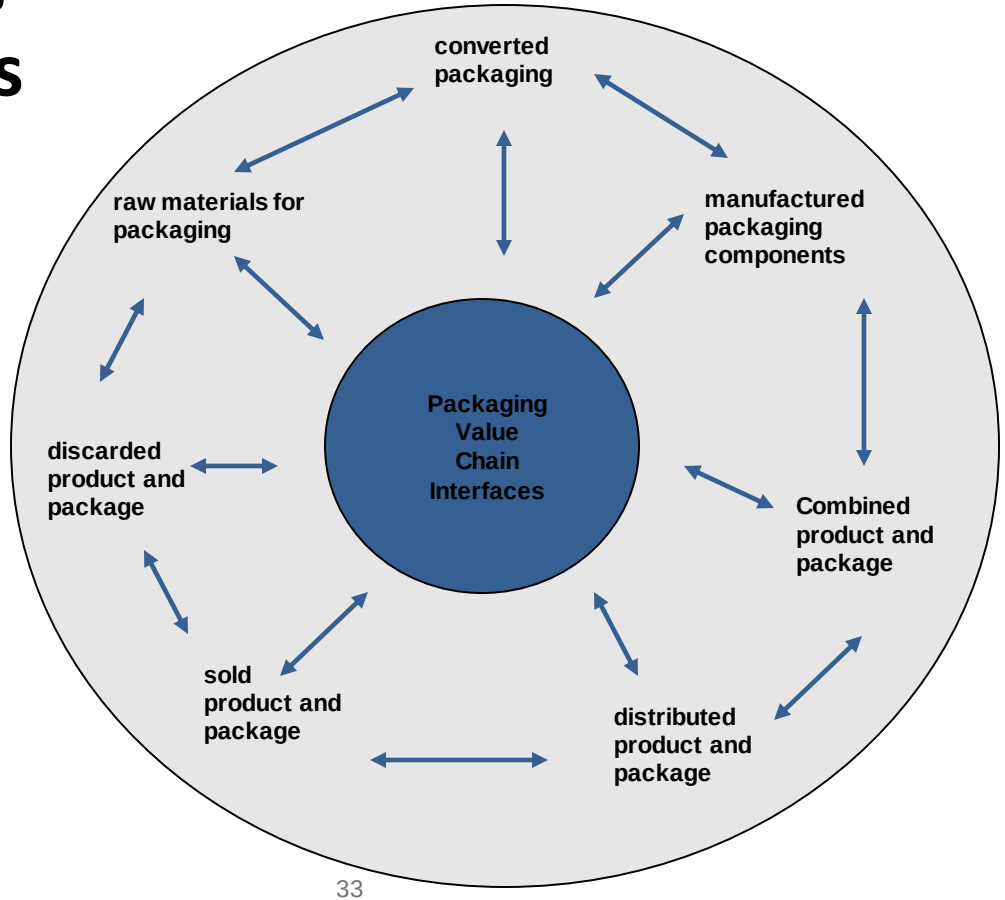
**Breakthroughs in packaging fraud needs concerted focus from food ingredients to finished goods packaging**



# Key Takeaways: Recap

- **Breakthroughs in intelligent packaging for reducing food waste:**
  - **Require deep research in material science and reaction rate modeling**
  - **Can be readily twisted from food fraud & marketing**
  - **Need multifaceted research to encompass the entire value chain**
  - **Connect to consumer cost savings from waste reduction**

- **Packaging fraud research needs concerted focus from food ingredients to finished goods packaging**

# Key Takeaways: Recap

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KEY TAKEAWAYS

1. Science & Modeling
2. Leveraged Research
3. Value Chain
4. Concerted Focus

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