Creating New Bioproducts Targeting Zero Waste Production

William Orts – Research Leader, Bioproducts
USDA Western Regional Research Center

24 Semptember 2020

USDA

USDA Western Regional Research Center

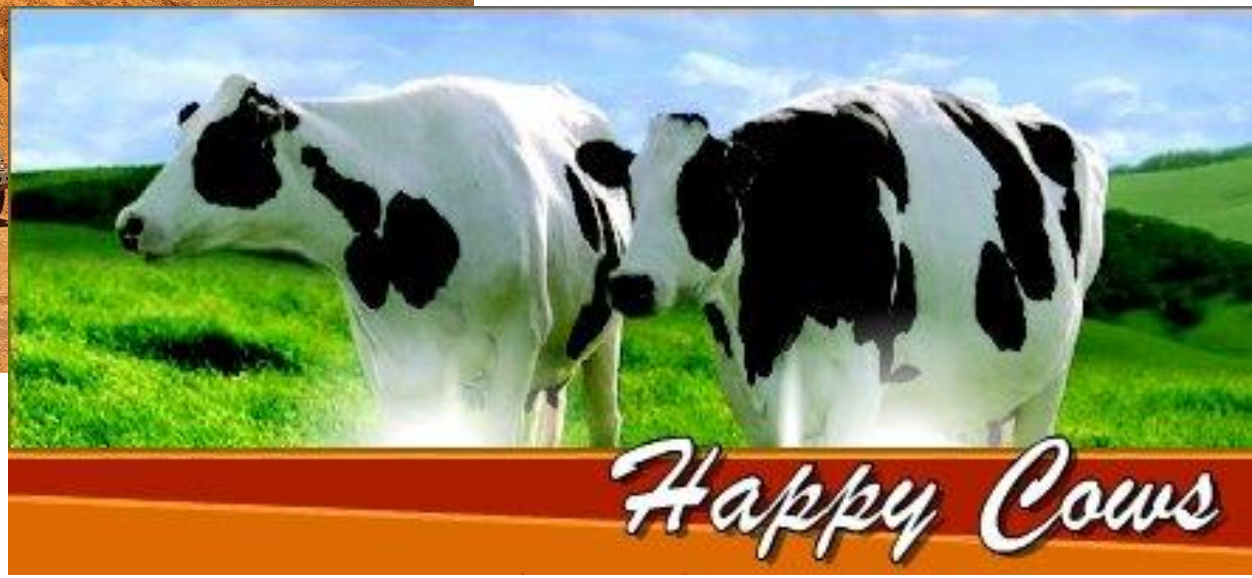
USDA ARS
Agricultural Research Service

Known for biotechnology especially crop biotech.

~390 people

~50 in Biofuels/ & Bioproducts

Almond Trees Produce Three Co-products



California's cows happily eat almond co-products

But lately, due to drought, change in markets, land costs, etc.

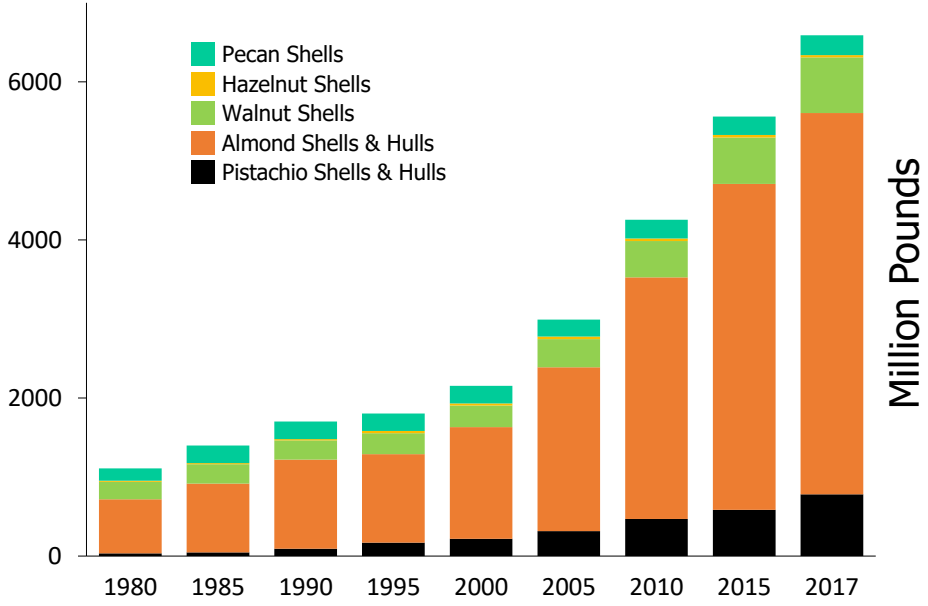
There are fewer cows and lots more almonds….

Strategic Driver: Agricultural Coproducts & Residues

California produces 82% of the world's almonds, resulting in nearly 0.95 million tonnes of shells annually and 1.1 million tonnes of hulls.

New markets for almond shells and other agricultural byproducts are needed.

US Tree Nut Biomass Production



Almond Hulls vs. Sugar Beets

Almond Hulls
30-35% sugar

Sugar Beet Cossettes
15-20% sugar

New uses for almond hull sugars

- **Ethanol ⇔ Biofuels**

- **Ethanol ⇔ Beer**

- **Edible Sugar ⇔ Bee Diets**

- **Edible Sugar ⇔ Sugar that is not high-fructose corn syrup**

What about the shells?

TORREFIED SHELLS: ADDING VALUE

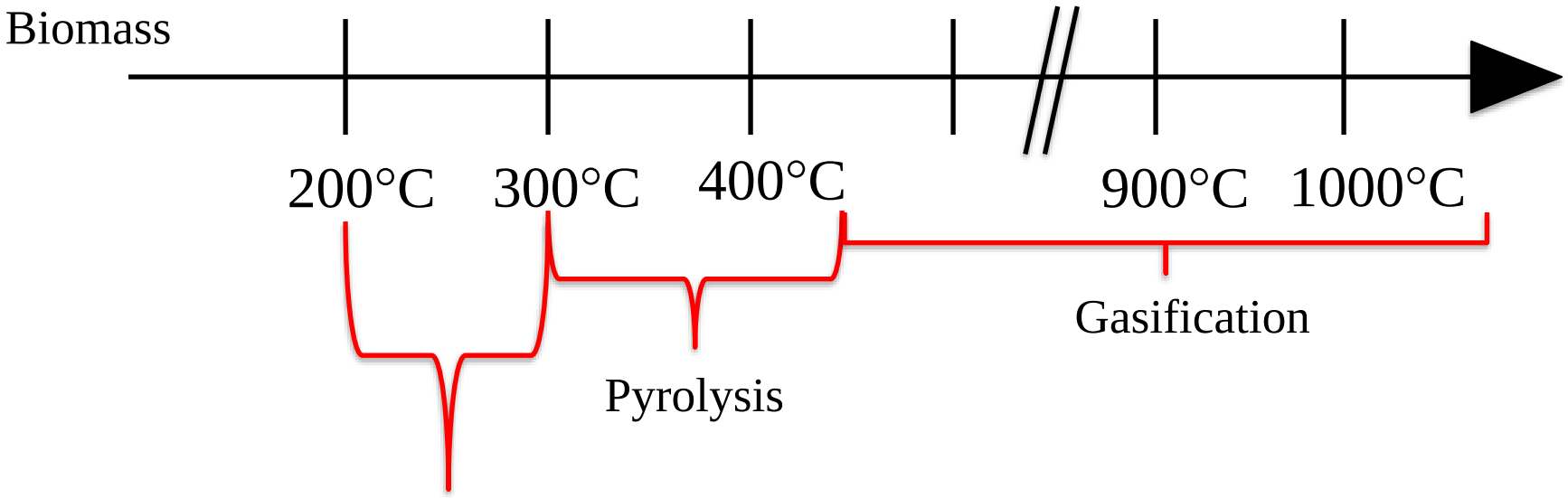
THE EFFECTS OF TORREFIED FILLERS ON THERMAL AND MECHANICAL PROPERTIES OF PLASTICS

Bor-Sen Chiou

Zach McCaffrey

Allison Flynn
Lennard Torres

Torrefaction, Pyrolysis & Gasification



Torrefaction

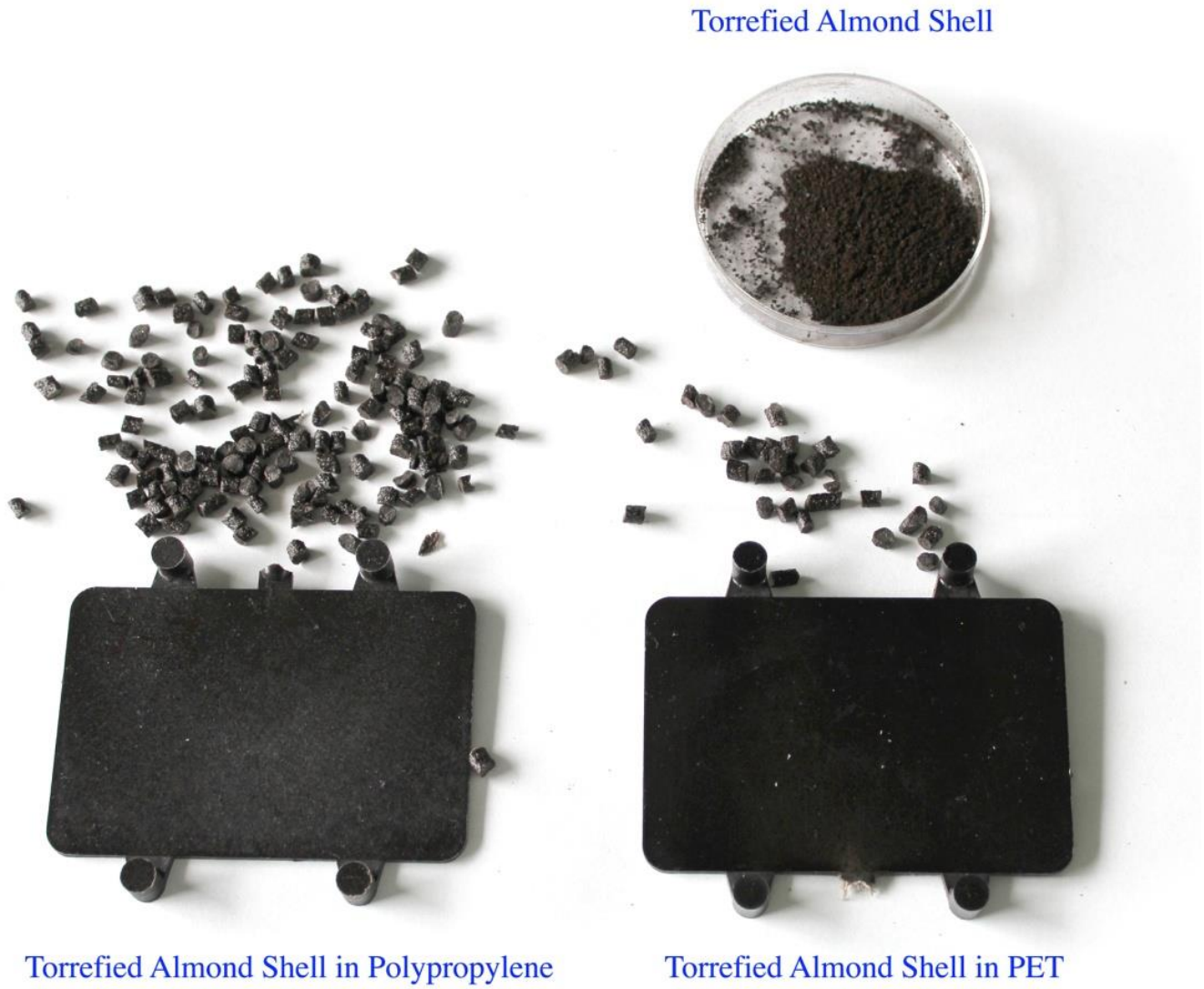
Densifies the biomass

Removes moisture and volatiles

What about converting shells to “biocoal”?

http://renewablefueltech.wordpress.com/

Torrefied Biomass-Polymer Composites

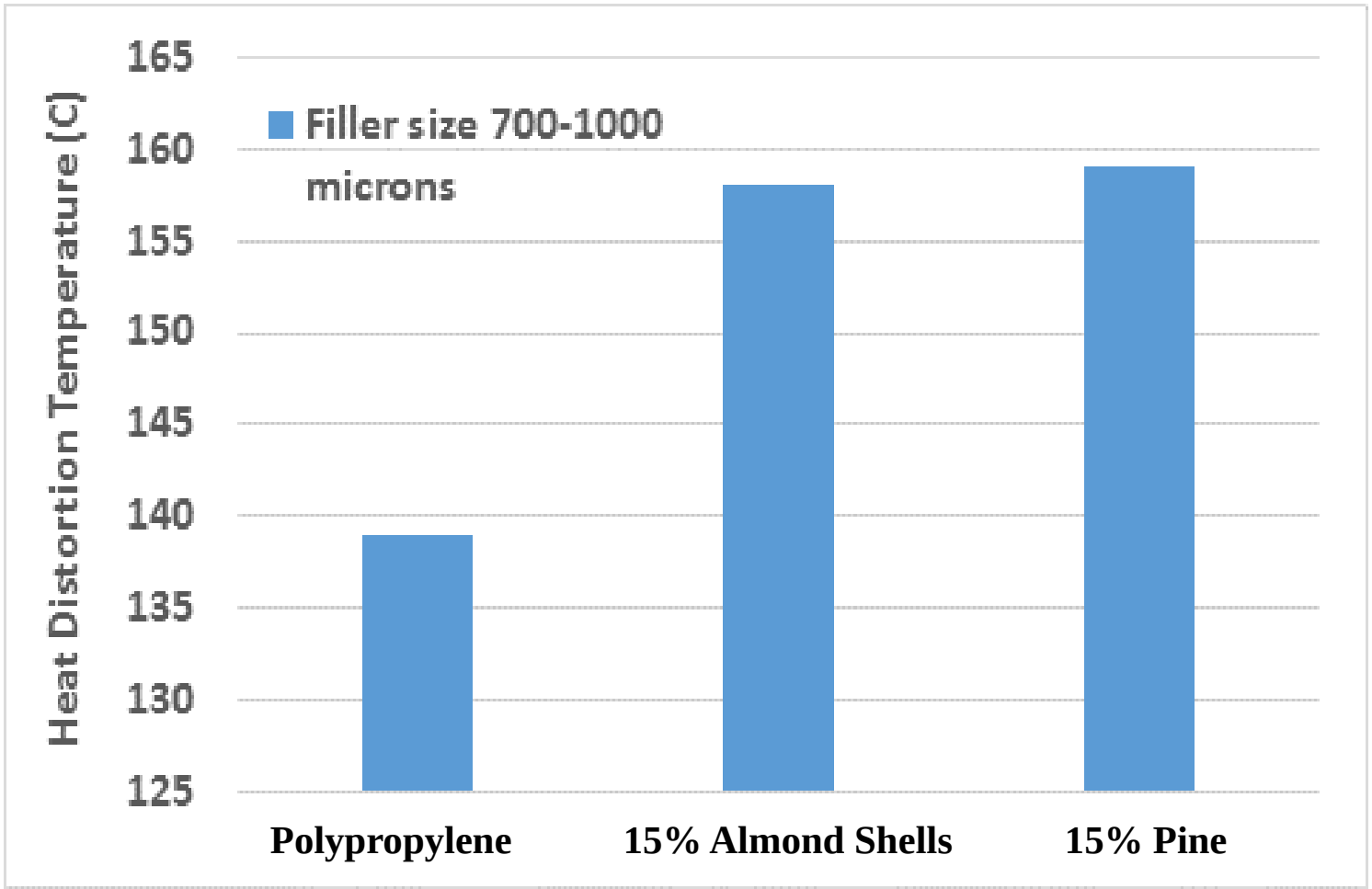


– Alternative to wood-polymer composites

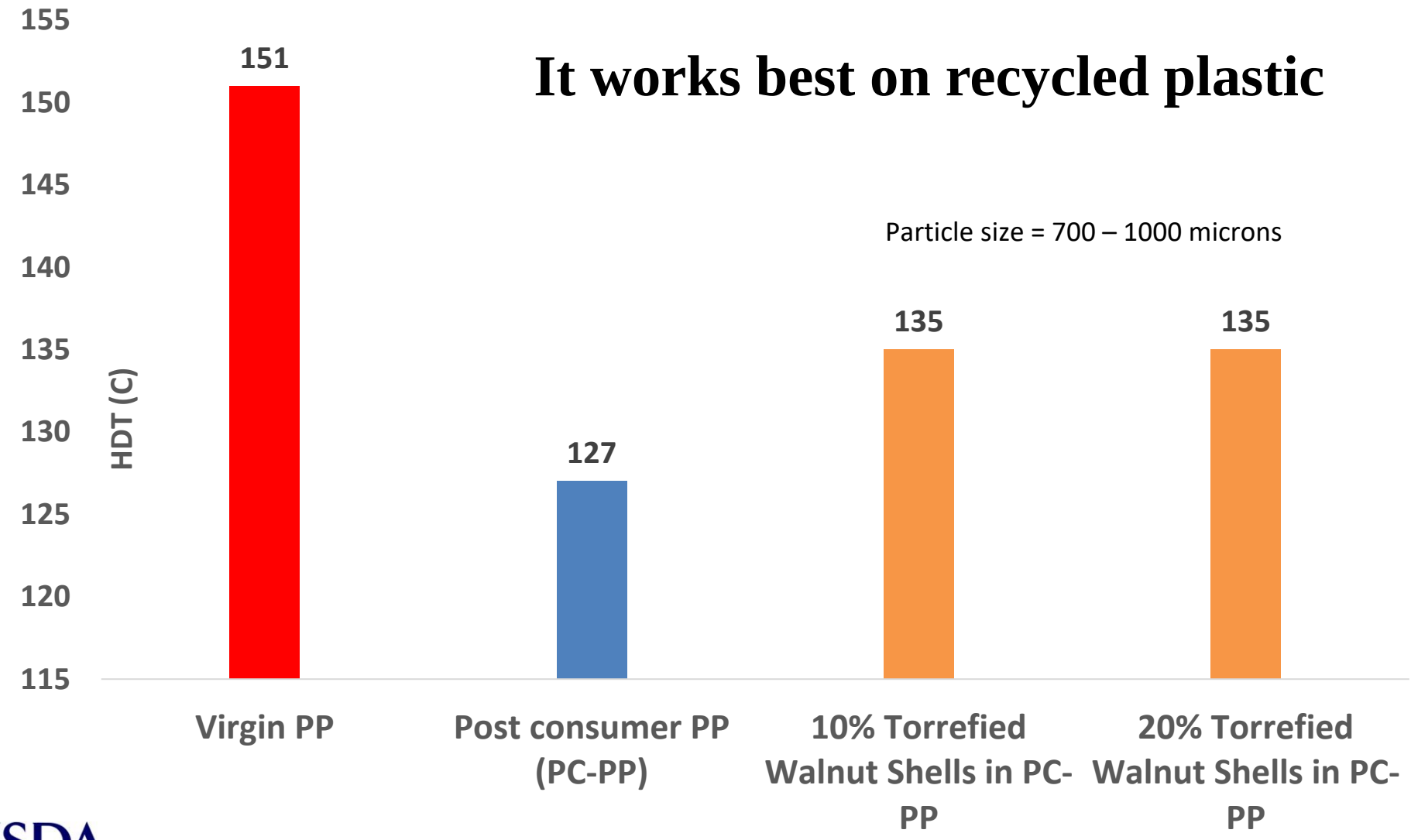
Heat Deflection Temperature

Temperature at which material deforms under specific load

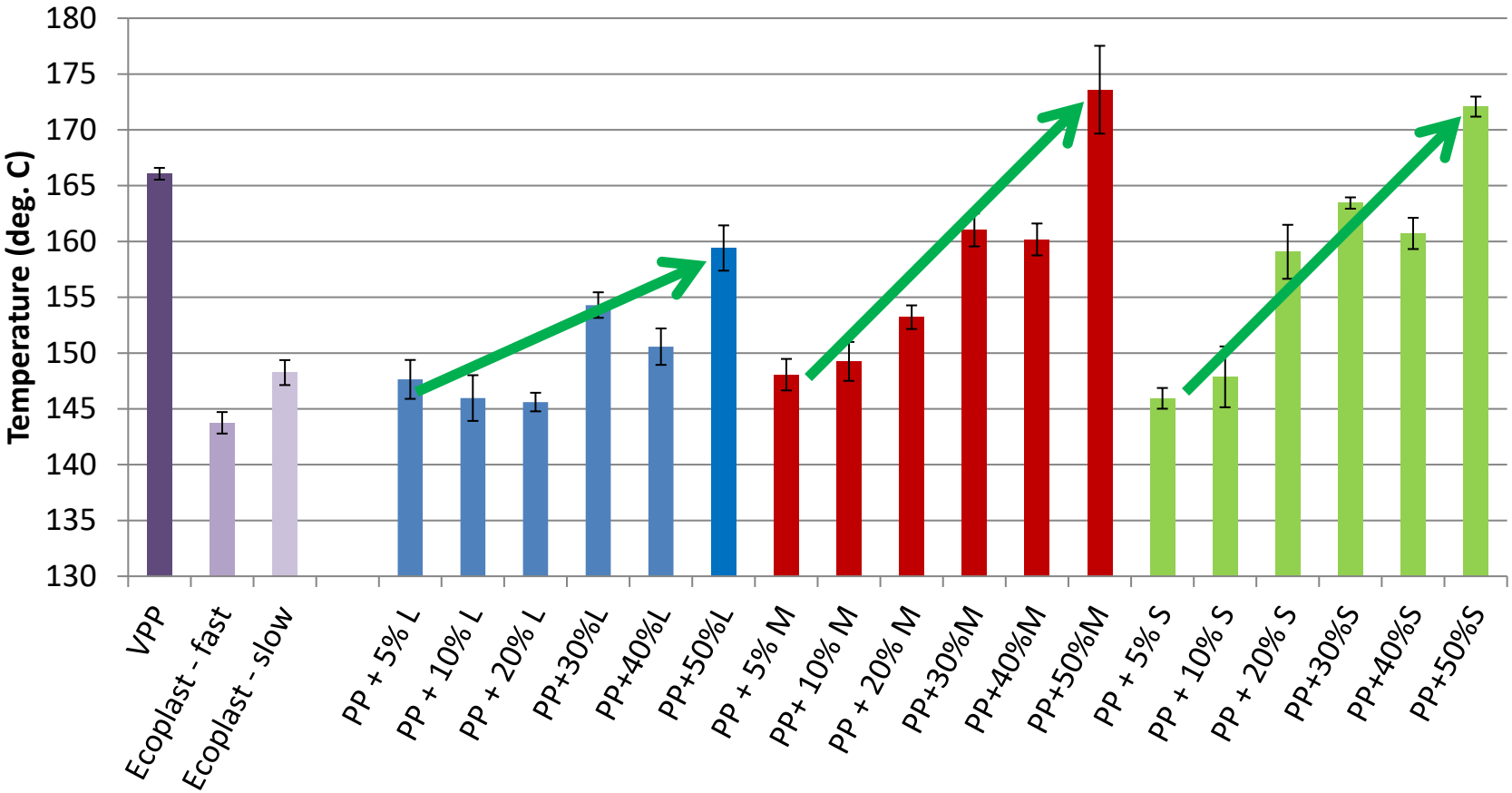
The softening point of plastics is improved by adding shells



Torrefied shells in polypropylene



HDT by Particle Size



>> Smaller size particles increase HDT

>> Higher % loading increase HDT

USDA

Post-Consumer Recycled PP/PE Blend

Torrefied Biomass in Plastics

Funded By CalRecycle

TRANPAK

F-D-S Manufacturing Co. Since 1950

RPAC LLC
ALMOND GROWER & PROCESSOR

USDA

Advantages of Torrefied Almond Shells as Plastics Additives

1) **Gives color, displacing carbon black & other pigments.**
2) **Increases modulus, making the final product more rigid, a property often lost in recycled plastics.**
3) **Increases heat stability, which provides market advantages, especially to thin-walled materials.**

USDA has enlisted strategic partners

TRANPAK

california almonds™ Almond Board of California

RPAC LLC ALMOND GROWER & PROCESSOR

MEGA MACHINERY INC.

Trex

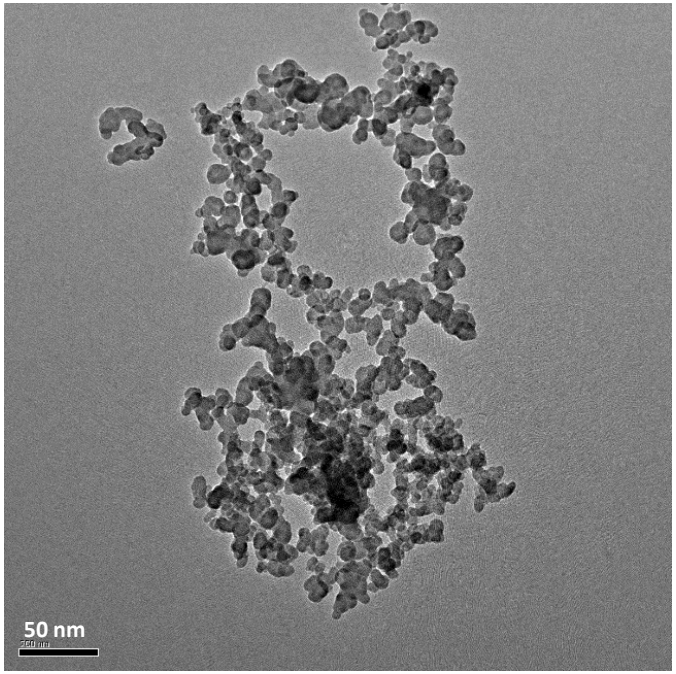
CalRecycle

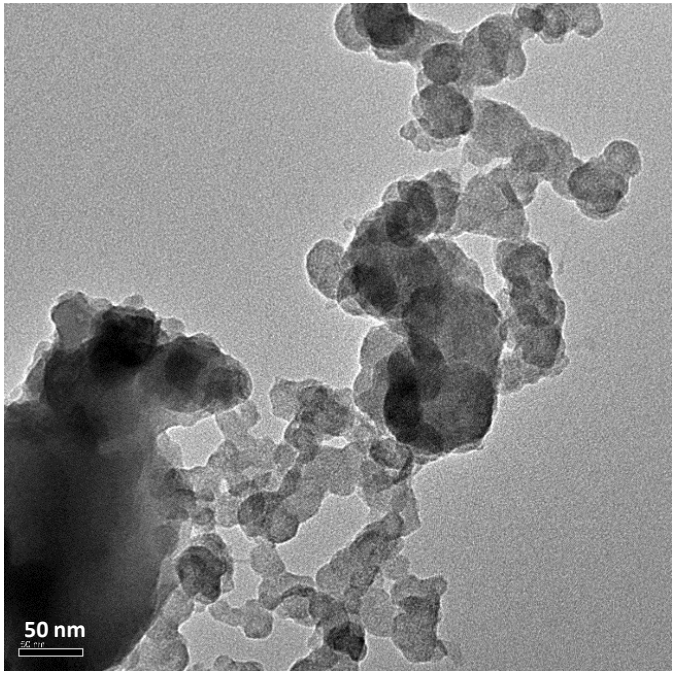
WESTBIOFUELS

Ford

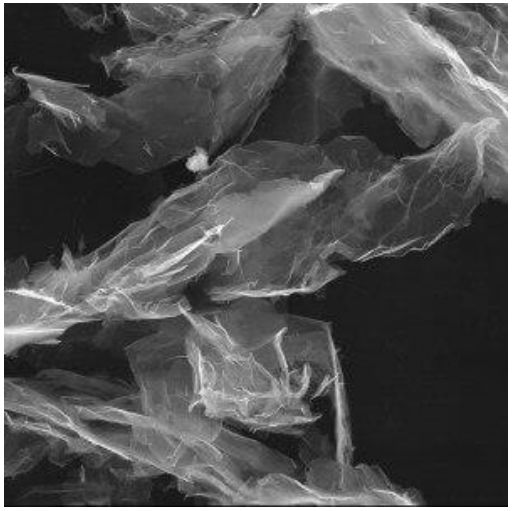
F-D-S Manufacturing Co. Since 1950

Graphene & Carbon Black from Torrefied Shells





TORREFIED SHELLS

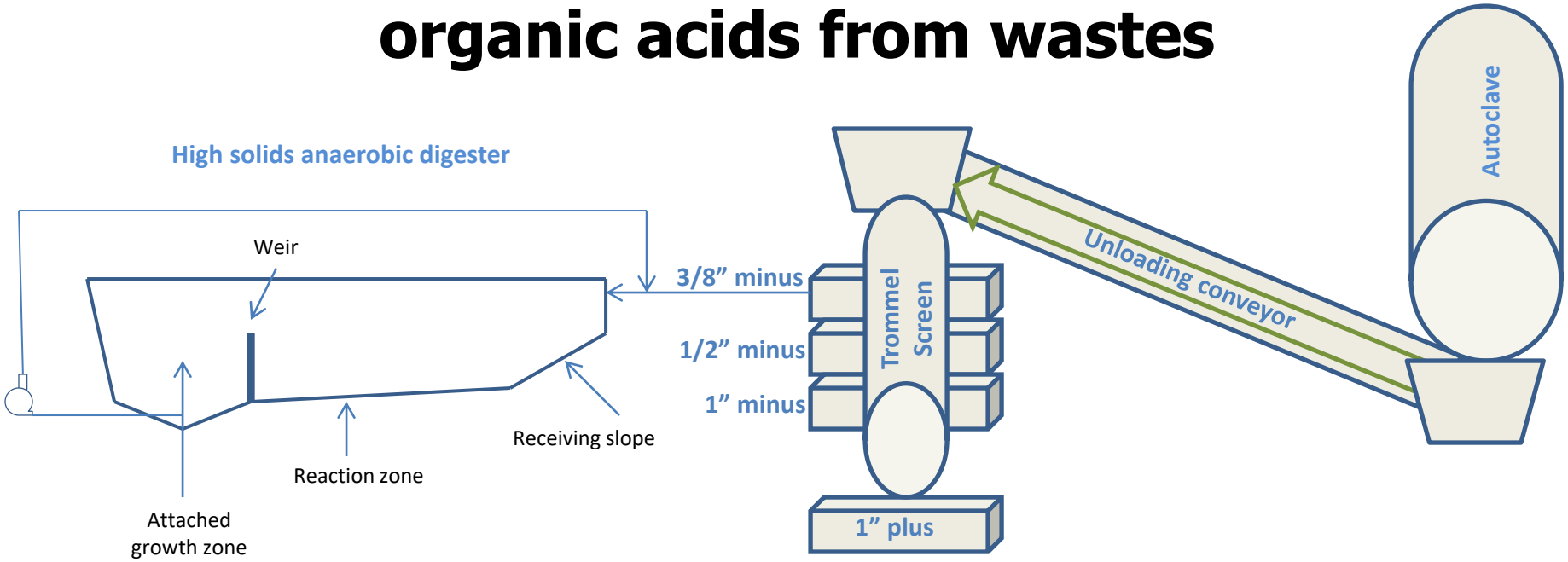


USDA

LIVING NANOTECH

What about food waste? Ag-residue?

Anaerobic digestion: Methane and organic acids from wastes



SALINAS VALLEY SOLID WASTE AUTHORITY
Promoting the Environmental Health of the Salinas Valley
Reduce Recycle Reuse

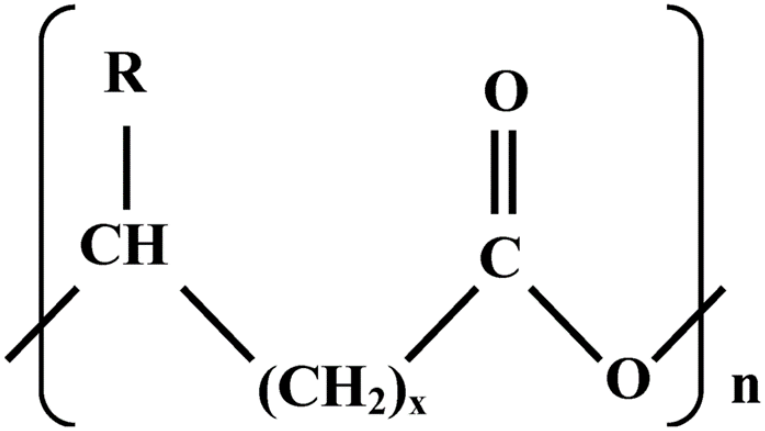
USDA

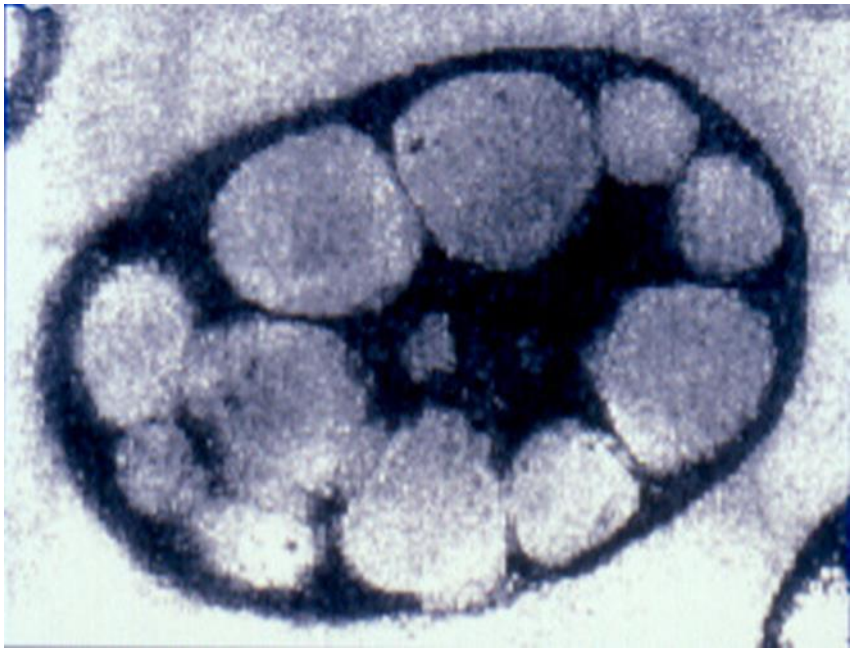
Kevin Holtman - USDA

Microbial biopolymers

PHA Biorefineries:

PolyHydroxyAlkanoates

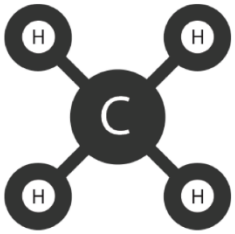




MANGO MATERIALS

FULL CYCLE
Bioplastics for the Circular Economy

Waste facility



Methane gas emissions

Microbial process

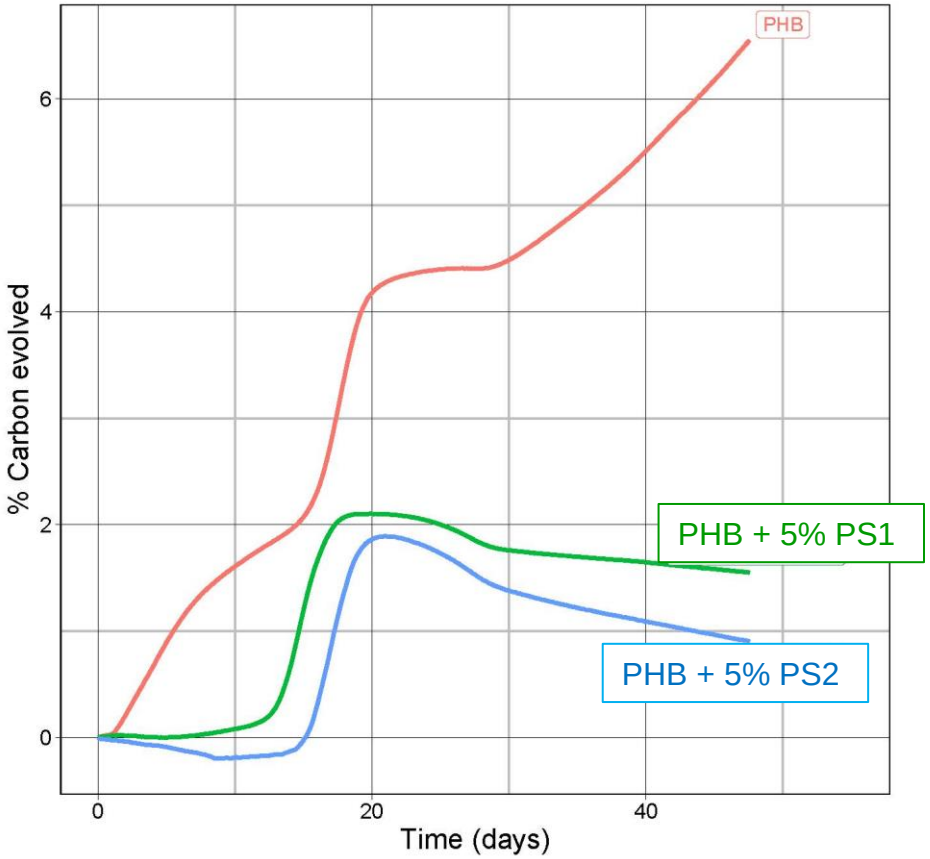
MANGOMATERIALS™

PHA biopolymer

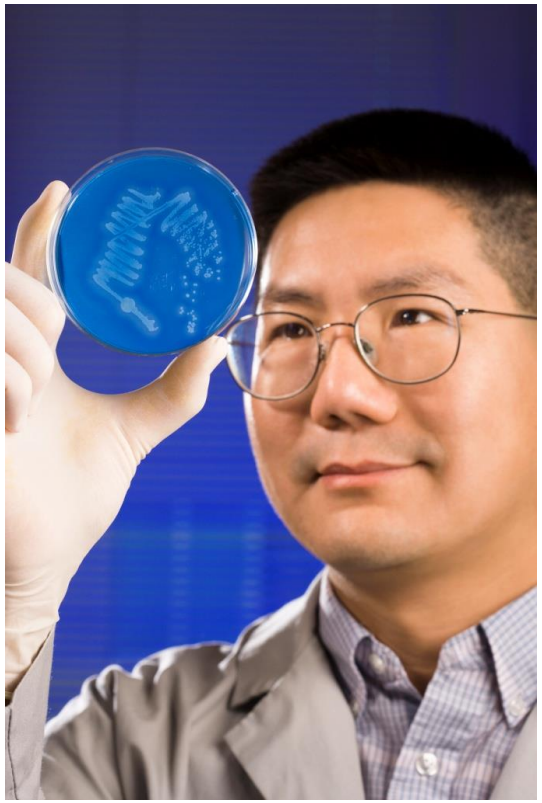
Biodegradable products

PHB modification to decrease rate of biodegradation

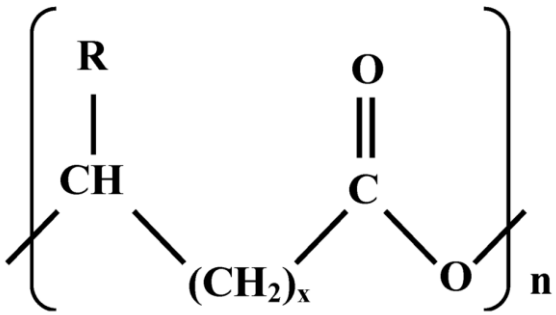
Low levels of polysaccharide additives dramatically reduces biodegradation rate



MANGO MATERIALS



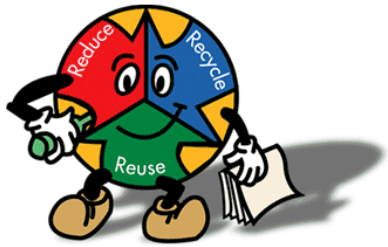
MANGO MATERIALS



PHA fibers from Ag-Wastes

Acknowledgements

Salinas Valley Solid Waste Authority
Promoting the Environmental Health of the Salinas Valley



MANGO MATERIALS

CORUMAT
BETTER MATERIALS

FULL CYCLE
Bioplastics for the Circular Economy

Almond Alliance
OF CALIFORNIA

california almonds

CALIFORNIA Walnuts
www.walnuts.org

TITUS
MRF SERVICES

F-D-S Manufacturing Co.
Since 1950

TRANPAK

RPAC LLC
ALMOND GROWER & PROCESSOR

Funded By CalRecycle

Researchers: Plastics & Composites

USDA Team

- De Wood
- Bor-Sen Chiou
- Zach McCaffrey
- Mark Wechsler
- Lennard Torres
- Charles Lee
- Andrew Cal
- Allison Flynn
- Trung Cao
- Artur Klamczynski
- William Hart-Cooper
- Gregory Glenn
- Colleen McMahan
- William Orts

Bill.Orts@USDA.GOV