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Quote in reference to: http://bit.ly/SweetChem

Fan of the Week

Todd Smeltz,
High School Math & Chemistry Teacher,
Upper Dauphin Area School District

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8

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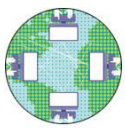

Thursday, June 16, 2016

Global Patents: Introduction to International Intellectual Property

Kazim Agha, Partner, Ridout & Maybee LLP
Sadiq Shah, Chair, ACS Committee on Patents and Related Matters

Thursday, June 23, 2016

Dreaming Big and Thinking Small: Applying Medicinal Chemistry Strategy to Antibody-Drug-Conjugates

Session 6 of the 2016 Drug Design and Delivery Symposium

L. Nathan Tumey, Associate Research Fellow, Pfizer, Inc.
Peter Senter, Vice President of Chemistry, Seattle Genetics

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10

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Discover the Chemistry of Candy and Chocolate in Rich's Past ACS Webinars!

"Sweet Science: Having Fun with Candy Chemistry**"**
See the Slides and Edited Webinar Here!
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"Halloween Candy Chemistry: Caramels, Gummies, Jellies, and Candy Corn**"**
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"Sweet Science: Chocolate Chemistry for Valentine's Day**"**
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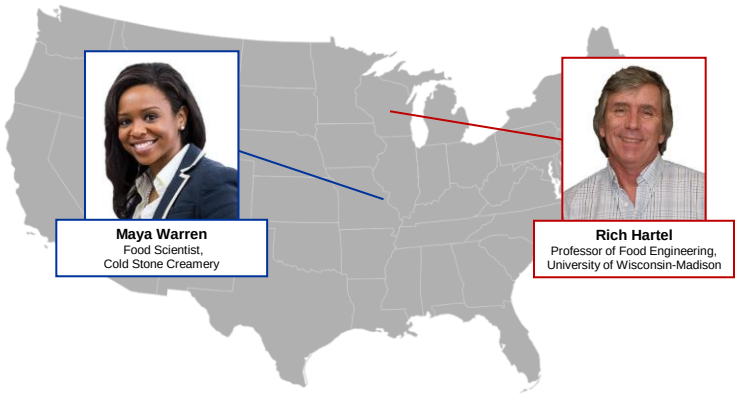
Ice Cream Chemistry



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12

ICE CREAM CHEMISTRY

Dr. Rich Hartel
University of Wisconsin-Madison

13

Outline

- **What is ice cream and how is it made?**
  - Even though there is a Standard of Identity, there is plenty of variation in commercial brands
- **Ice cream structure**
  - A complex multi-phase system
- **Ice cream melting**
  - What factors affect melt-down rates?

If you're following along by eating ice cream, put a scoop of each product on a plate and watch what happens when it melts.

14

Ice Cream - Defined

- **Product that meets the Standard of Identity according to the Code of Federal Regulations**
  - Minimum of 10% fat
  - Maximum of 100% overrun

  Overrun(%) = Volume ice cream/Volume mix

  - So 100% overrun means the volume of mix is doubled by addition of air
    - Cheaper ice creams tend to have close to 100% while super-premium brands are closer to 40%

15

Ice Cream Sandwiches That Don't Melt?

- You've all heard that certain brands of ice cream sandwiches don't melt?
- Walmart ice cream under scrutiny when Cincinnati mom says it doesn't melt.

What causes that?

Walmart says:
"Ice cream melts based on the ingredients including cream. Ice cream with more cream will generally melt at a slower rate, which is the case with our Great Value ice cream sandwiches."

16

Ice Cream & the OJ Trial

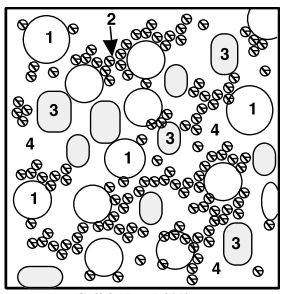
- Prosecutors say the murders happened about 10:15 p.m. But police found a container of melting Ben & Jerry ice cream at the crime scene about 12:15 a.m. Defense attorneys are suggesting that, because the ice cream wasn't totally melted by 12:15, the murders had to have happened after 11 p.m. - when O.J. was already on his way to the airport.

Is it possible to tell time by ice cream "melting"?

17

Ice Cream at a Structural Level - A Multi-Phase Product

- **Ice crystals**
  - Provide cooling effect and hardness
- **Air cells**
  - Reduce density
- **Partially-coalesced fat globule network**
  - Affects melt-down rate and hardness of ice cream
- **Proteins and hydrocolloids**
  - Network in serum phase
- **Serum phase**
  - Dissolved sugars, minerals, proteins, etc.
  - Some liquid even at very low temperature

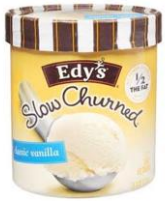


18

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

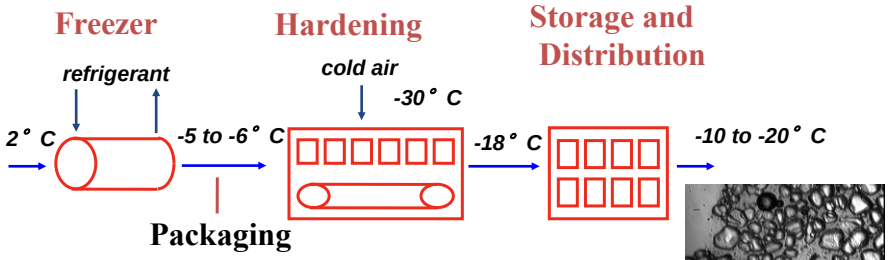
What's the difference between Edy's/Dreyer's regular and Slow-Churned?



- Slow-churned has half the fat but tastes just as creamy
- Slow-churned costs more
- They have different formulations and different manufacturing processes
- All of the above

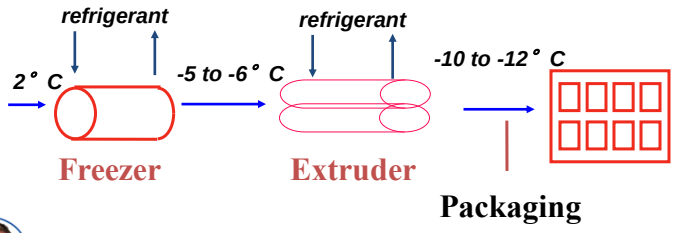
19

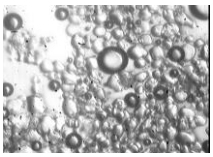
Edy's Full Fat Vanilla



L = 54.0 µm

Edy's Slow-Churned Vanilla



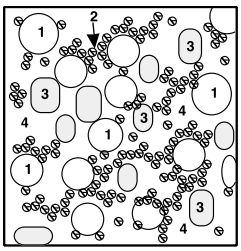


L = 34.0 µm

20

Factors that Influence Meltdown

- **Heat transfer**
  - Overrun, number and size of air bubbles
  - Outside temperature, convective factors
- **Ice content**
  - Thermal diffusivity – insulation effect
- **Viscosity of serum phase**
  - Diluted by melted ice
- **Gravity**
  - Ability of serum phase to flow
- **Fat globule clusters**
  - Number and size



21

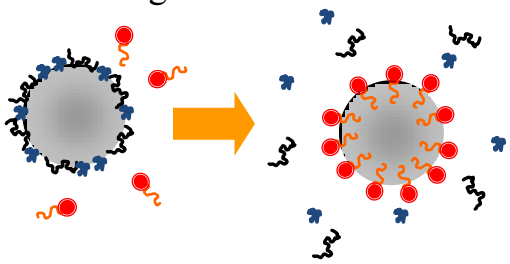
Ice Cream Melting

Not all ice creams are created equal – or melt in the same way

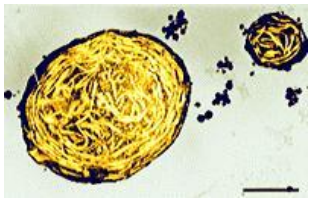
22

Fat Globules in Ice Cream Mix

- **Emulsion droplets in mix**
  - Coated with protein/emulsifier surface after homogenization
  - Emulsifier replaces protein during ageing
  - Partially crystalline milk fat network within globules



Courtesy: J McClements

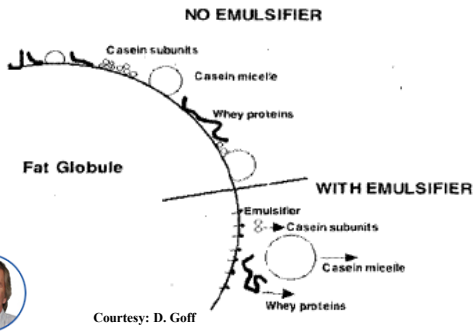


Ice cream mix fat globules
(Doug Goff, University of Guelph)

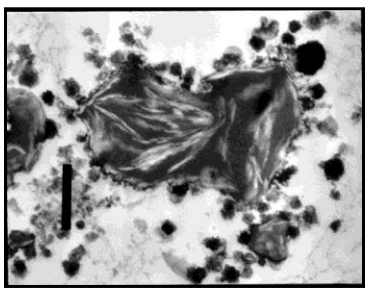
23

Emulsifier Addition

- Destabilizes the emulsion
  - Reduces interfacial tension, and reduces the interfacial viscosity
  - During freezing, emulsion droplets are forced together under shear and coalescence is initiated



Courtesy: D. Goff

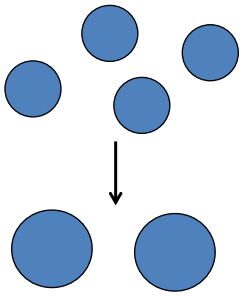


Cryo-TEM from D. Goff

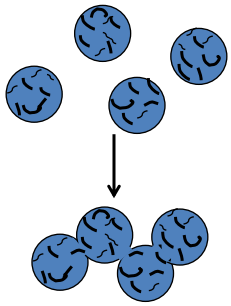
24

Coalescence or Partial Coalescence

Coalescence
Liquid droplets

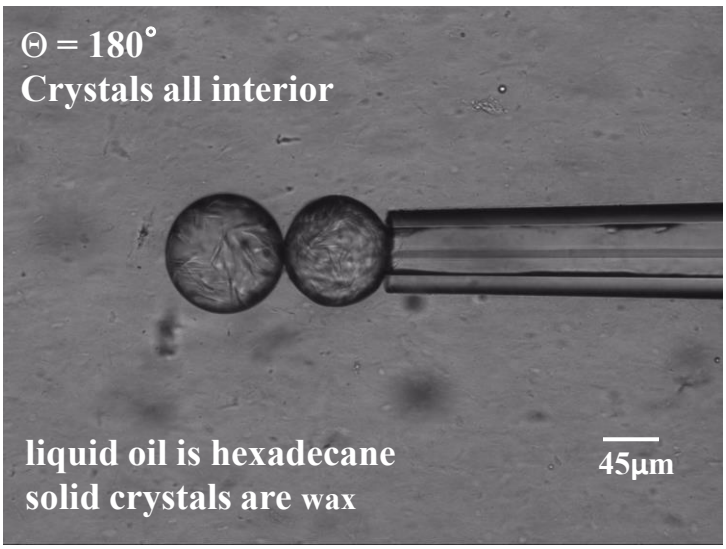


Partial Coalescence
Semi-crystalline



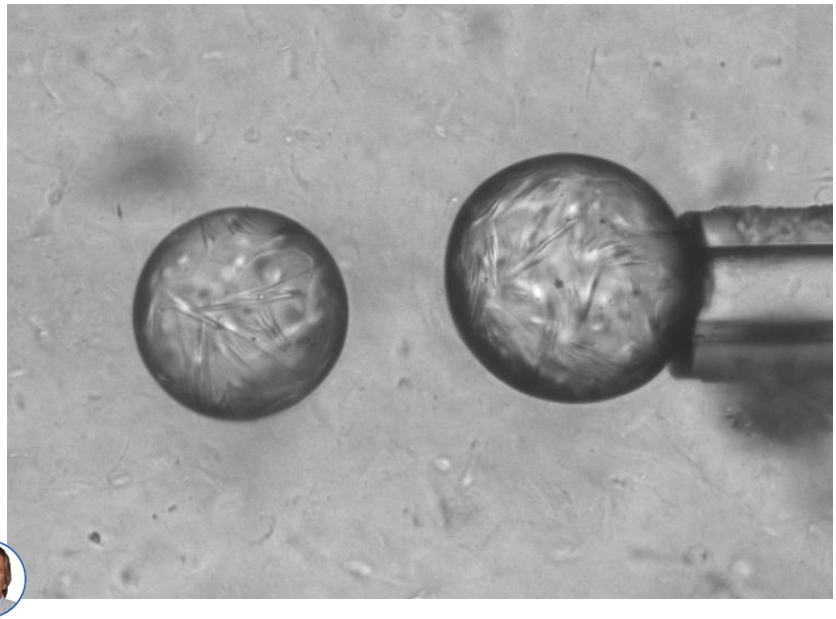
25

Partial Coalescence



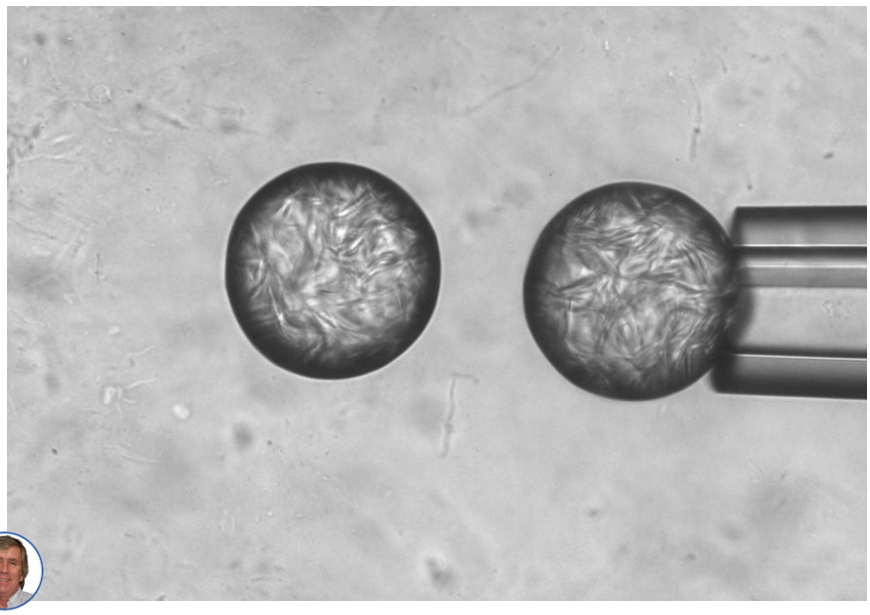
26

30% Solid Fat Content (SFC)



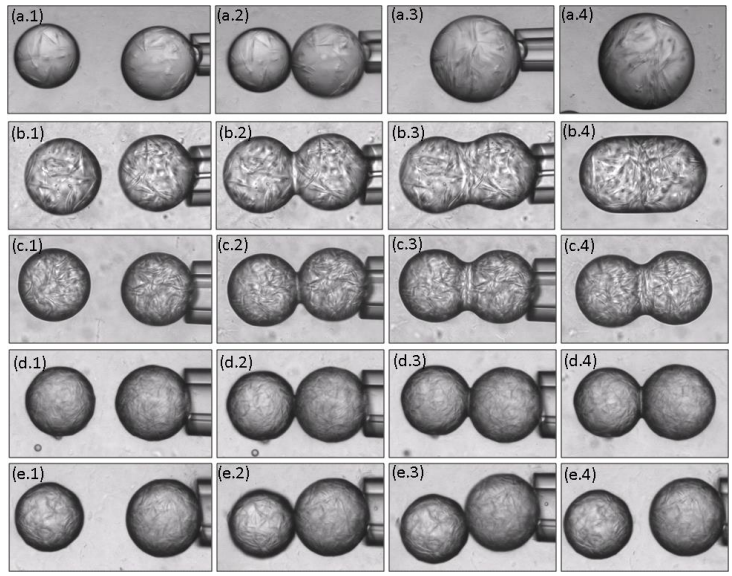
27

40% Solid Fat Content (SFC)



28

Partial (arrested) Coalescence

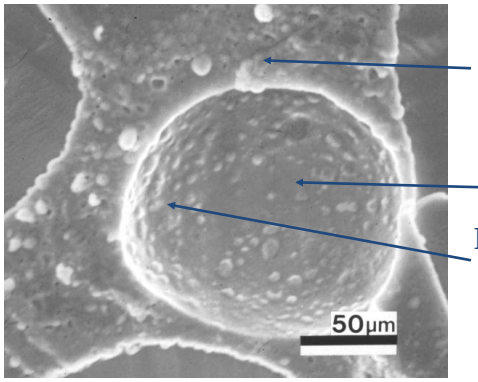


Pawar et al., 2012

29

Partial Coalescence in Ice Cream

- In ice cream, emulsion droplets partially coalesce and cover the air cell interface
  - Provide structural support for air cells

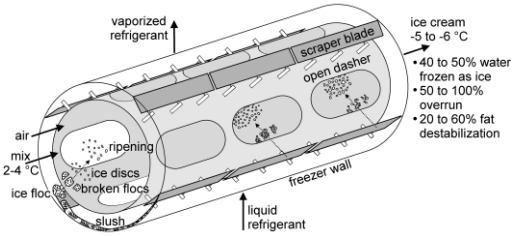


Ice cream viewed by cryo-SEM (D. Goff, Guelph)

30

Partial Coalescence in Ice Cream

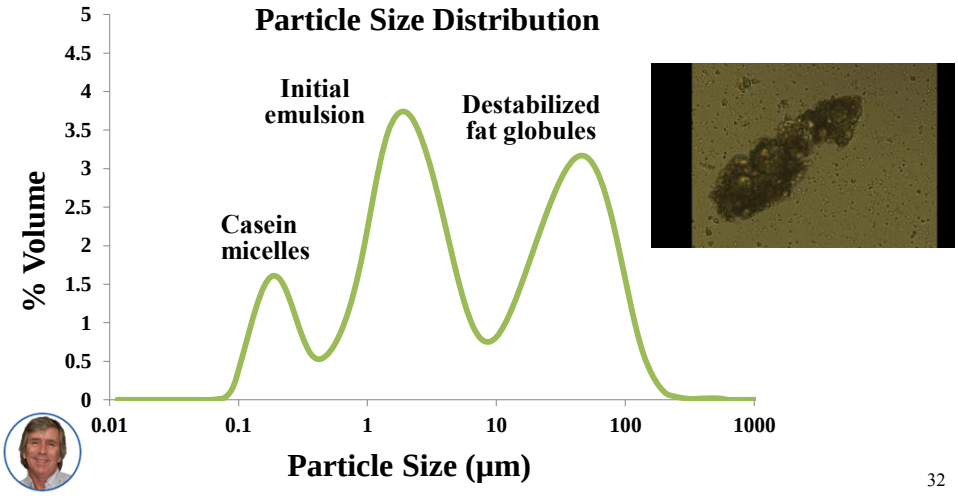
- **In the short time the ice cream spends in the freezer, the fat globules (with 50-60% solid fat content) must come together to form 3-D clusters that subsequently support and help stabilize the air cells**
  - Extensive shear forces at work to disrupt the O/W interface and allow the coalescence process to begin
  - The rigidity of crystal network within the fat globules prevents complete coalescence



Cook & Hartel (2010)

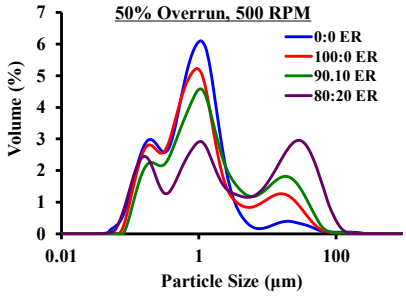
Measuring Partial Coalescence

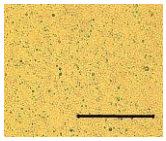
- Measured with light scattering technique

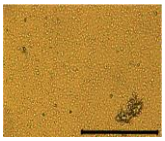


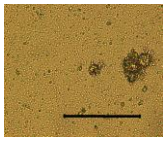
Controlling Partial Coalescence

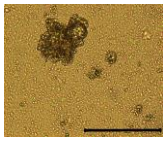
- **Addition of emulsifiers**
  - Polysorbate 80 (PS80)
  - Mono & diglycerides (MDG)
  - Ratio (ER=MDG:PS80)
- **Shear stress in the freezer**
  - Ice phase volume
    - Freezing point depression
  - Overrun
  - Dasher speed




0:0 ER, 5.9%


100:0 ER, 19.6%

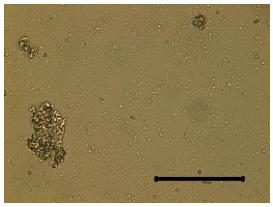

90:10 ER, 28.3%

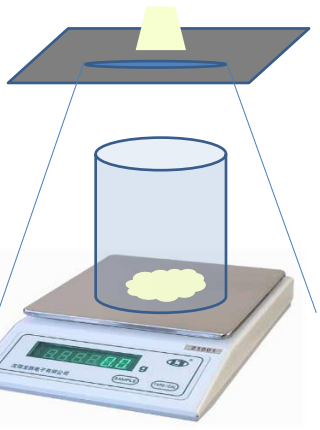

80:20 ER, 56.2%

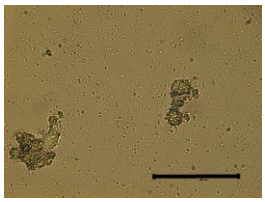
33

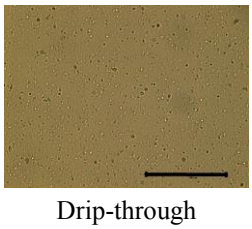
Meltdown/Drip-through Test

The Role of Fat Globule Clusters


Whole melt/melted ice cream



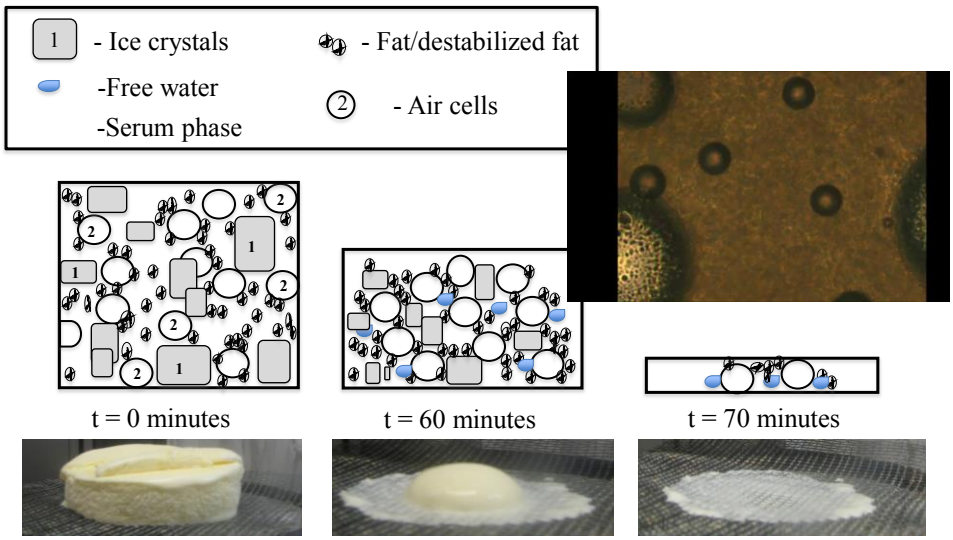

Top/remnant foam


Drip-through

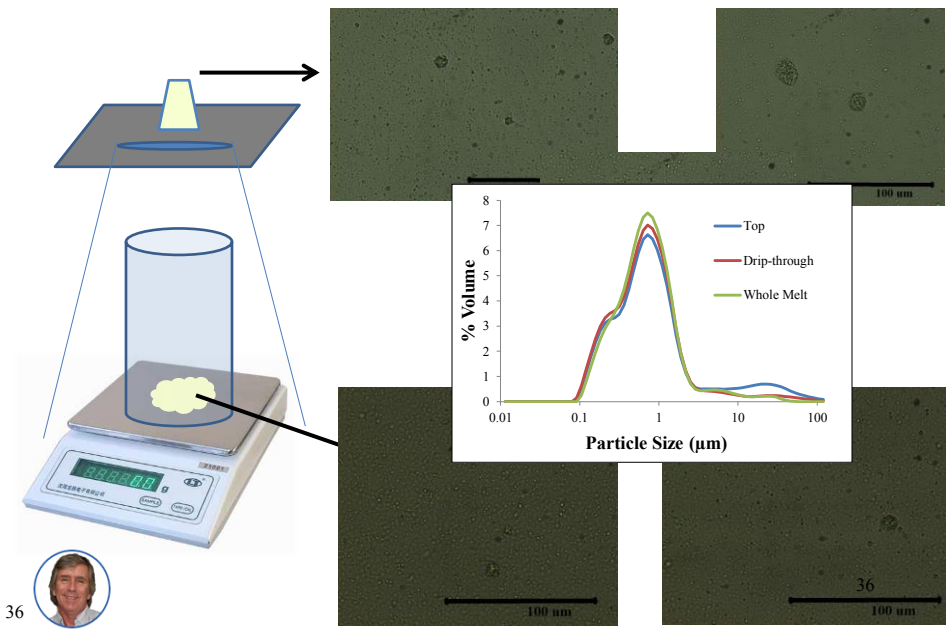
Up to 2 hrs at room temp
Plot weight vs time, take slope to obtain rate of melt

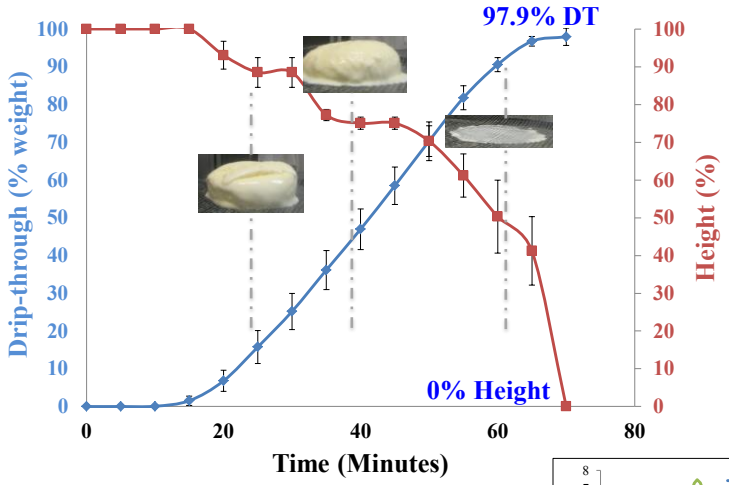
34

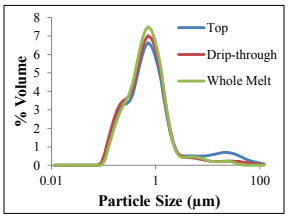
Low Fat Destabilization, Full Collapse and Drip-Through



Fast Drip-638: 5% FD







Sample 638

- **Fast drip-through rate**
- **Minimal partial coalescence**
- **No stand-up properties**

37

High Fat Destabilization, Minimal Collapse

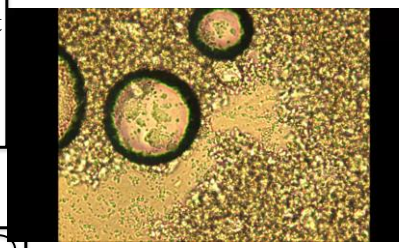
1 - Ice crystals

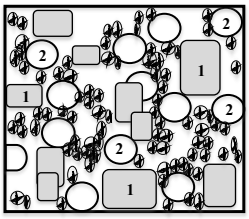
- Fat/destabilized fat

-Free water

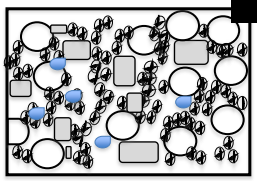
-Serum phase

2 - Air cells

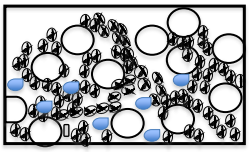




t = 0 minutes



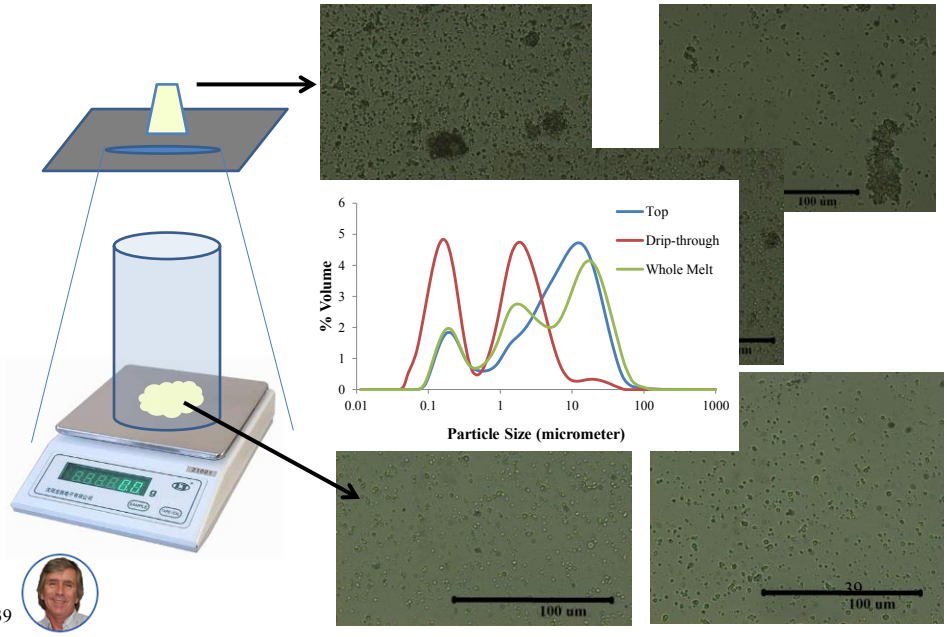
t = 60 minutes



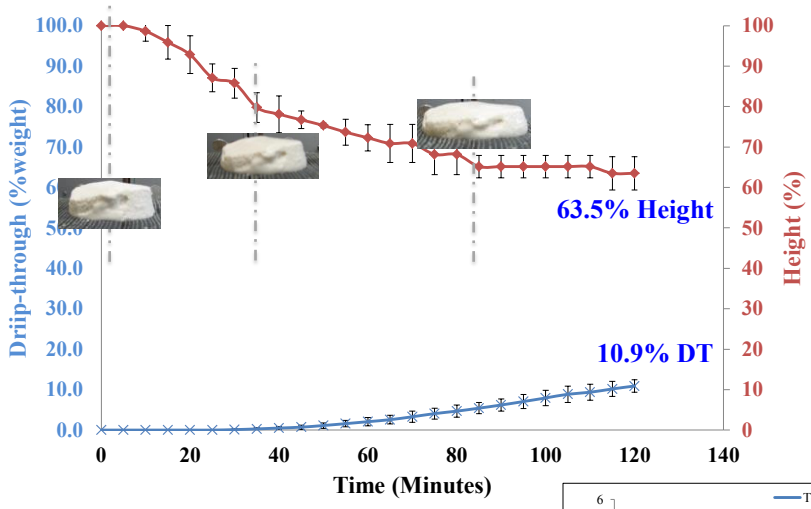
t = 120 minutes

38

Slow Drip-293: 55.3% FD

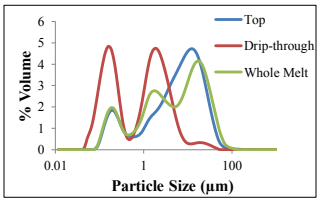


39

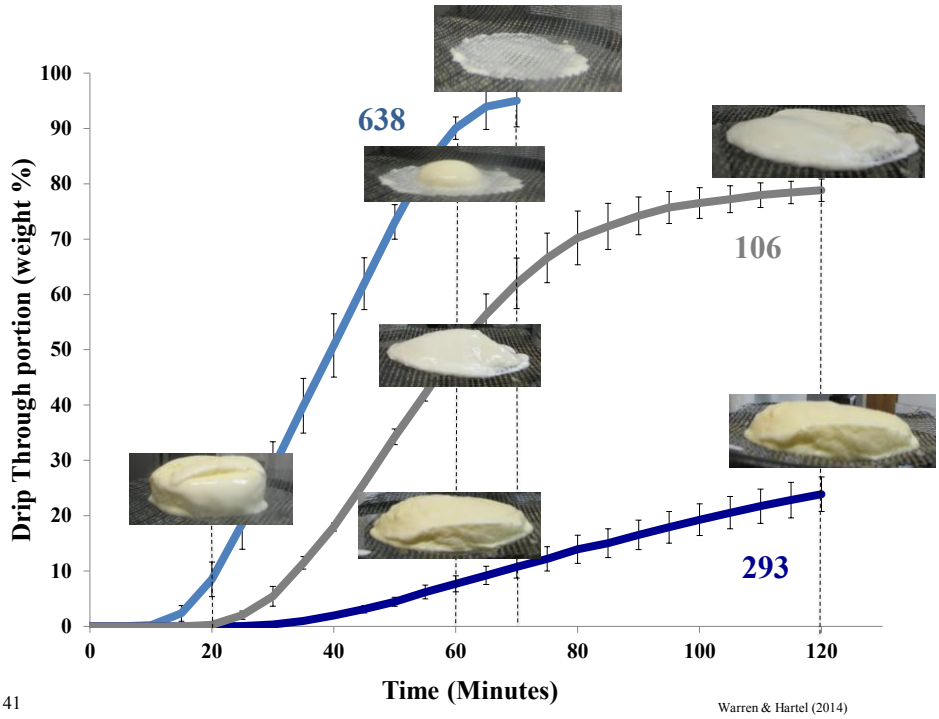


Sample 880

- Slow drip-through
- Large partial coalescence
- High stand-up properties



40



41

Warren & Hartel (2014)

Audience Survey Question

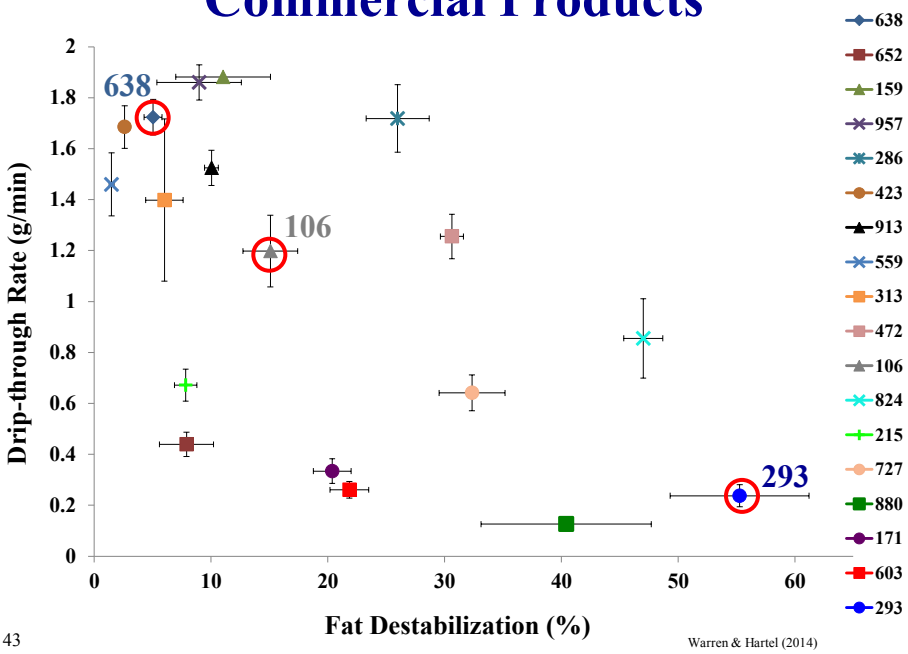
ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

Did you see a difference in melt-down of your ice cream samples and if so what was different between them?

- Fat content
- Overrun
- Stabilizer/thickener
- Emulsifier
- All of the above

42

Commercial Products



Warren & Hartel (2014)

Wrap Up

- **Walgreen's ice cream sandwiches**
  - Melting and collapse are two different phenomena, each governed by numerous parameters
  - The Walgreen's ice cream has melted, but because of the structures, it doesn't collapse – other commercial products show the same behavior
- **B&J ice cream in the OJ trial**
  - Yes, it'd be possible to predict time based on collapse (not "melting") of but control experiments would be needed

Ice cream - one of the most complex food products

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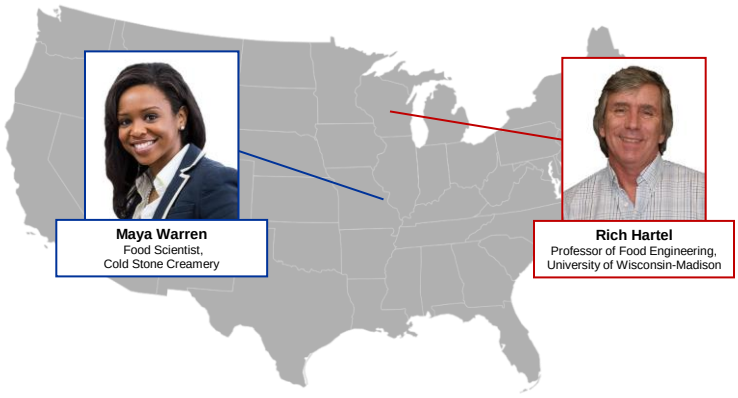

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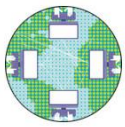

Thursday, June 16, 2016

Global Patents: Introduction to International Intellectual Property

Kazim Agha, Partner, Ridout & Maybee LLP
Sadiq Shah, Chair, ACS Committee on Patents and Related Matters

Thursday, June 23, 2016

Dreaming Big and Thinking Small: Applying Medicinal Chemistry Strategy to Antibody-Drug-Conjugates

Session 6 of the 2016 Drug Design and Delivery Symposium

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Peter Senter, Vice President of Chemistry, Seattle Genetics

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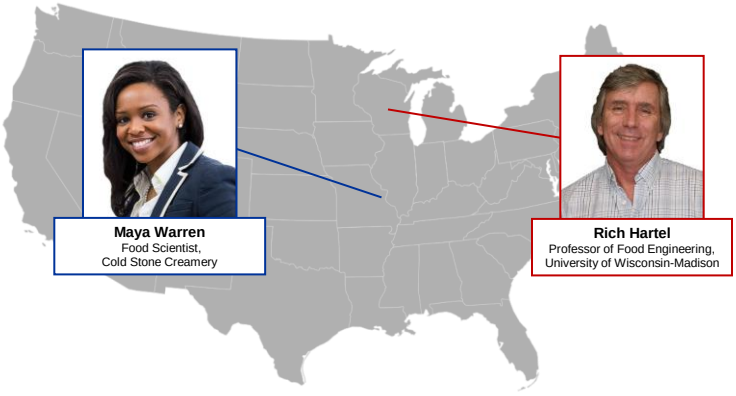

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47

Final Thoughts?

48

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Quote in reference to: http://bit.ly/SweetChem

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Todd Smeltz,
High School Math & Chemistry Teacher,
Upper Dauphin Area School District

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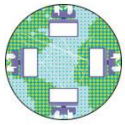

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53