

In one month, this is what you left in my street
Samuel (9 years)



Saskia Vanstichele-Knack Jan 2019

PLASTICS
INNOVATION
Competence Center



EUROPEAN PLACE
17TH BIENNIAL TAPPI EUROPEAN PLACE CONFERENCE



20-22 May 2019 · Crowne Plaza · Porto, Portugal

Plastics or Planet? A View into the Future

Presented by:
Rudy Koopmans
Plastics Innovation Competence Center
HESSO-HEIA-FR Fribourg

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Hes-SO HEIA-FR

The Plastics Perception



Blue Planet II
Nov 2017

Planet or Plastics
National Geographic
June 2018



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What is the Problem?

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A Brief History



**Synthetic chemistry - The last 160 years:
Making & breaking strong covalent bonds**

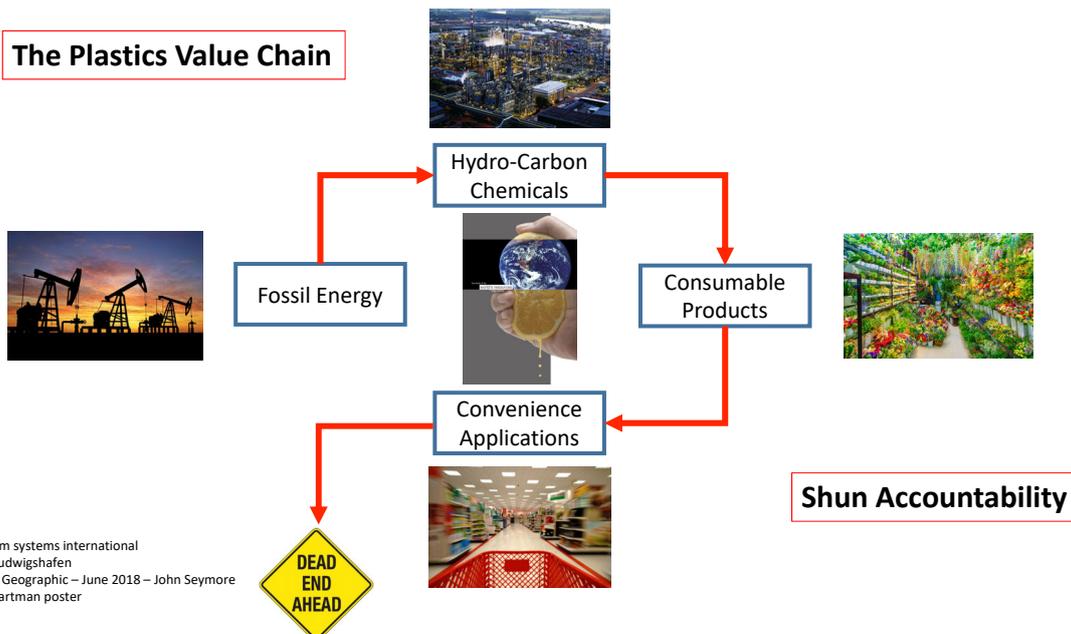
**Archibald Scott Couper (1831-1892)
1858 – Tetra-Valence of Carbon**

A.S. Couper (14 June 1858) "[Sur une nouvelle théorie chimique.](#)"
(On a new chemical theory), *Comptes rendus*, **46** : 1157-1160.

Source: <https://sciencenotes.org/today-in-science-history-march-11-archibald-scott-couper/>

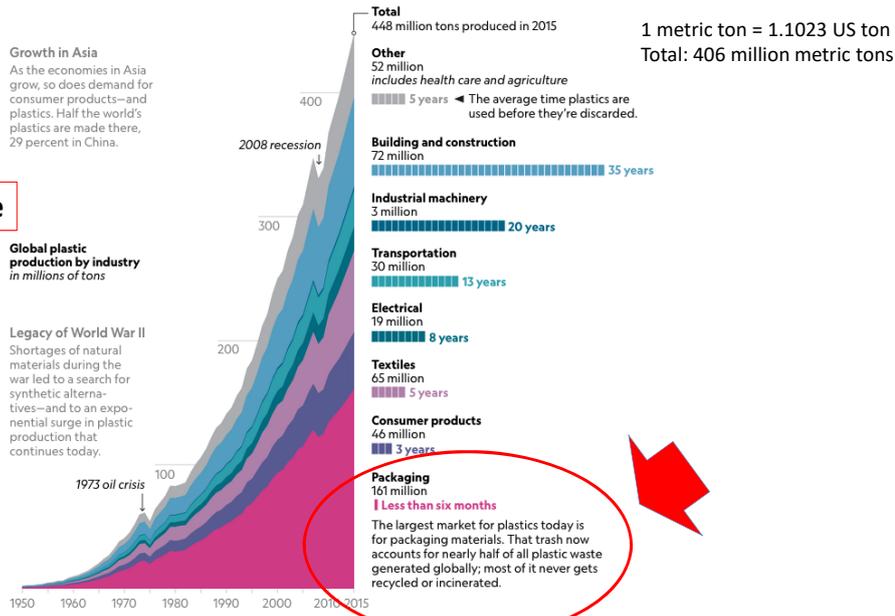
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The Plastics Value Chain



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Global Plastics Volume

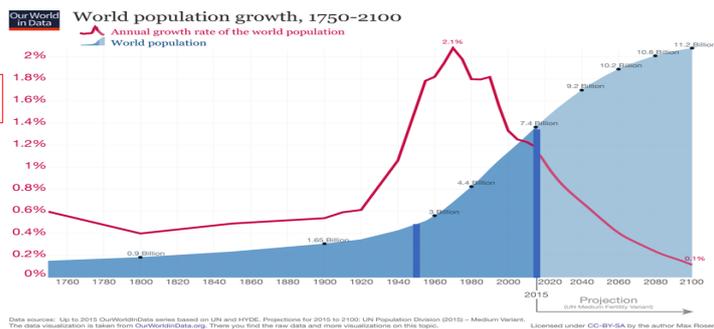


JASON TREAT AND RYAN WILLIAMS, NGM STAFF
SOURCE: ROLAND GEYER, UNIVERSITY OF CALIFORNIA, SANTA BARBARA

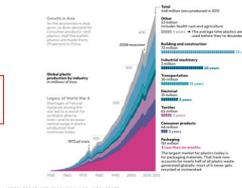
Source: National Geographic Magazine June 2018

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Global Population



Global Plastics Volume



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Convenience and Individualization



From Cow to Consumer (and back)?

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The Alternatives



Average package weight per 100g product

Options require choice and have consequences

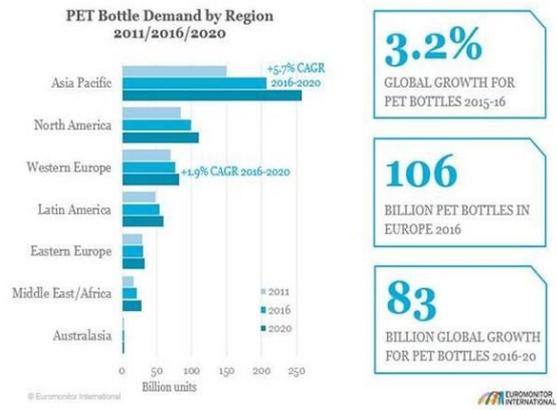


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Marketeers

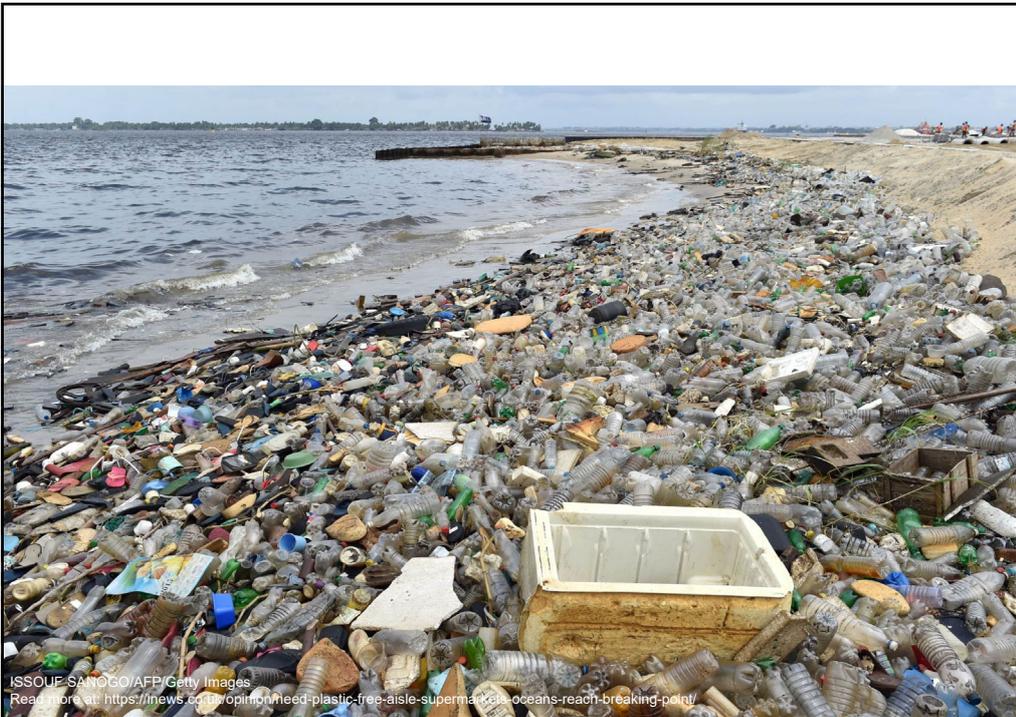


Source Picture: indiamart.com



~ 500 Billion = ~ 16000/sec

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**The True Life
of
the PET Bottle**

ISSOUE SANOGO/AFP/Getty Images
Read more at: <https://news.co.uk/opinion/need-plastic-free-aisle-supermarket-oceans-reach-breaking-point/>



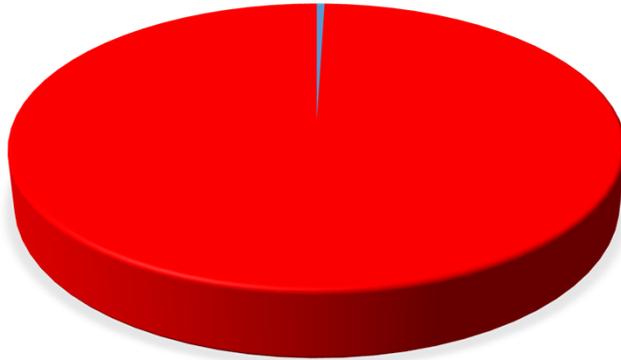
Microplastics

Photography:
Mandy Barker
National Geographic

"Bio"- Plastics

PLASTICS TODAY

"Bio" Plastics



~2 MM vs. ~406 MM

Global production capacity data for 2015/2016 (solid bars) and announced production capacities for 2020 (shaded bars) of bio-based biodegradable polymers (Green), bio-based non-biodegradable (drop in) polymers (Blue) and fossil-based biodegradable polymers (Red) (IFBB, 2016); (European Bioplastics, 2016) (van den Oever, Molenveld, van der Zee, & Bos, 2017)

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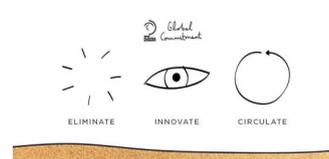
Composting

R. Koopmans - München October 2018

A Paradigm Shifting Wave



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Bali, 29 October 2018 - A Global Commitment to eradicate plastic waste and pollution at the source has been signed by 250 organisations including many of the world's largest packaging producers, brands, retailers and recyclers, as well as governments and NGOs.

EU action plan for the Circular Economy

- A common EU target for recycling 65% of municipal waste by 2035; (current ~40% current - 2015)
- A common EU target for **recycling 70% of packaging waste by 2030**; (current ~25% recycled – 50% landfill - 2015)
- There are also recycling targets for specific packaging materials:
 - Paper and cardboard: 85 %
 - Ferrous metals: 80 %
 - Aluminium: 60 %
 - Glass: 75 %
 - **Plastic: 55 % !**
 - Wood: 30 %
- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2035;
- Separate collection obligations are strengthened and extended to hazardous household waste (by end 2022), bio-waste (by end 2023), textiles (by end 2025).
- Minimum requirements are established for **extended producer responsibility** schemes to improve their governance and cost efficiency.
- Prevention objectives are significantly reinforced, in particular, requiring Member States to take specific measures to tackle food waste and marine litter as a contribution to achieve EU commitments to the UN SDGs.

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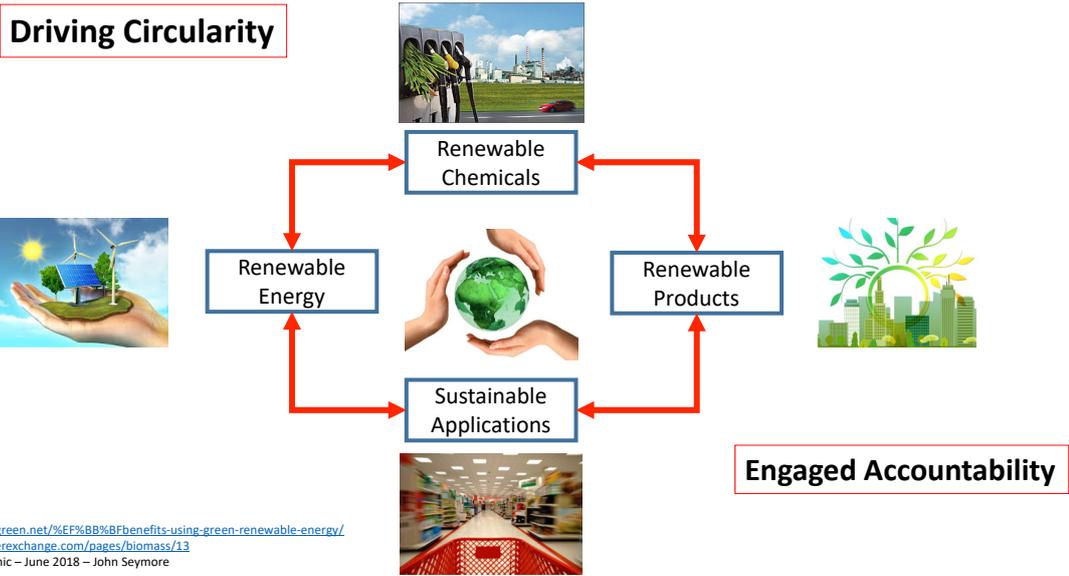
Single Use Plastic

	Consumption reduction	Market restriction	Product design requirement	Marking requirements	Extended producer responsibility	Separate collection objective	Awareness raising measures
Food containers	X				X		X
Cups for beverages	X				X		X
Cotton bud sticks		X					
Cutlery, plates, stirrers, straws		X					
Sticks for balloons		X					
Balloons				X	X		X
Packets & wrappers					X		X
Beverage containers, their caps & lids			X		X		X
- Beverage bottles			X		X	X	X
Tobacco product filters					X		X
Sanitary items:							
- Wet wipes				X	X		X
- Sanitary towels				X			X
Lightweight plastic carrier bags					X		X
Fishing gear					X		X

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Solutions

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Towards a Renewable & Circular Plastics Industry - BioEconomy

- Act 1:
 - Address the existing
 - Simplification, Identification, After-use Infra-Structure (Recover, Re-use)
- Act 2:
 - Address the novel
 - Use nature's polymers (un-valorized Biomass)
- Act 3:
 - Address alternative synthetic polymers
 - Use nature's chemicals & principles (un-valorized Biomass)



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Act 1



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Would you sort your rubbish in 7 different bags?



<https://www.bbc.com/news/av/business-47880558/would-you-sort-your-rubbish-into-seven-different-bags>
Douglas Shaw for BBC business

City of Eskilstuna – Sweden

Municipal waste: 50% recycled – now!

0% Landfill

50% Energy recovery (but CO₂ ☹)

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Recycling



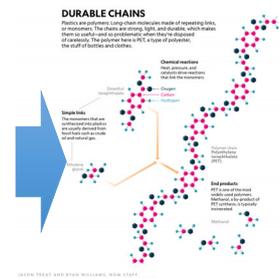
Source Picture: indiamart.com



12x



Source Picture: Daniel Sarabia AB



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Act 2



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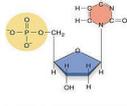
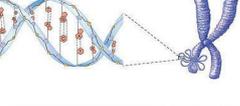
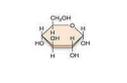
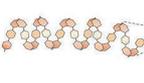
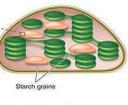
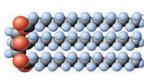
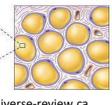
A Brief History

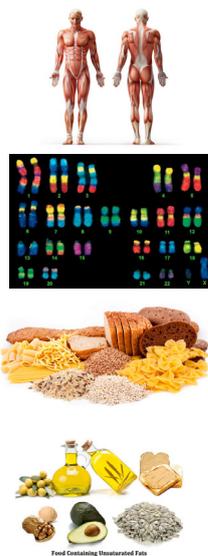


Nature - The last 1 Billion years:
Organize molecules using weak bonds

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Nature's Polymers

Biomolecules		
Monomer	Polymer	Cellular structure
Amino Acid 	Polypeptide 	Intermediate filament 
Nucleotide 	DNA strand 	Chromosome 
Monosaccharide 	Starch 	Starch grains in a chloroplast 
Fatty acid 	Fat molecule 	Adipose cells with fat droplets 



Function

Information

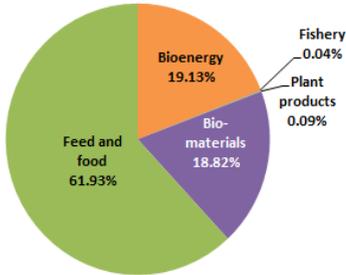
Energy

Facilitation

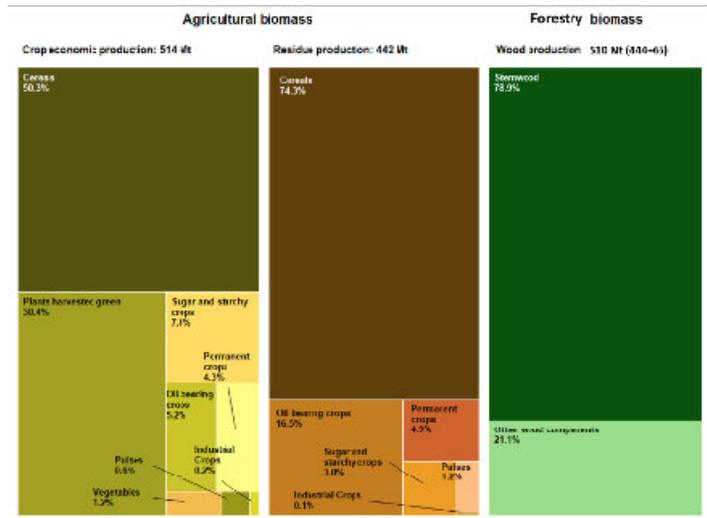
Source: Review of the Universe, [Molecules] in website: universe-review.ca

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**(Dry) Biomass
EU 28 – Annual Production
1,466 Million Tons**



Actual use 805 Million Tons !



Biomass production, supply, uses and flows in the European Union - EUR 28993 EN - 2018 (2013 estimates) <https://ec.europa.eu/jrc>

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Packaging in Nature



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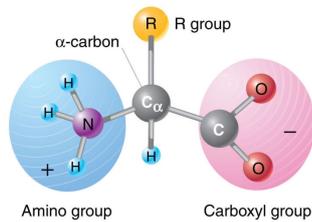
Natural Proteins (Polymers)

Un-valorized Proteins from Textile & Food Industry

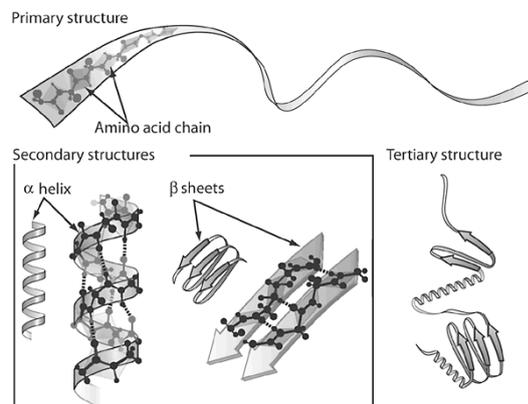


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Proteins



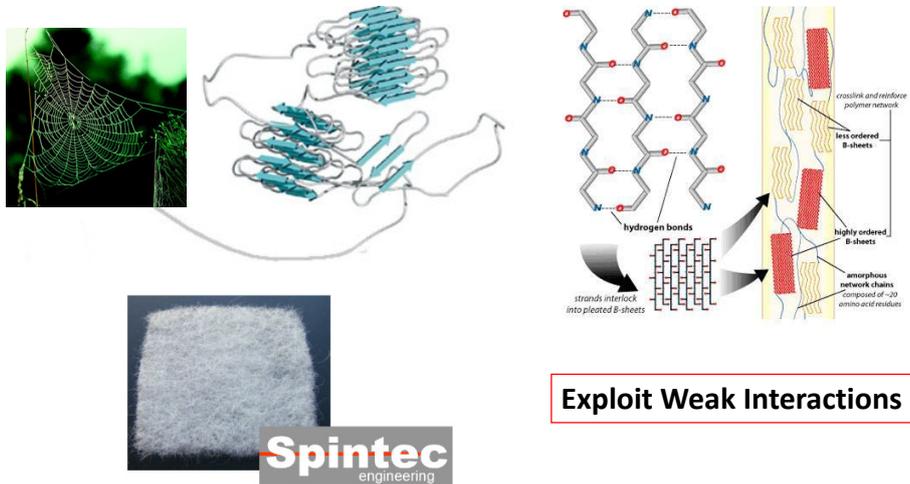
**Amino-Acids (21):
Versatile Building Blocks
Functional & Chiral**



Source Pictures: Courtesy Prof. A. Aggeli

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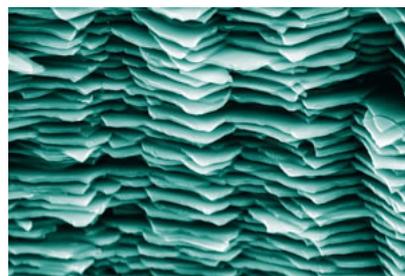
Self Assembled Proteins: Spider Silk



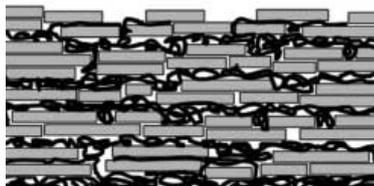
Exploit Weak Interactions

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Symbiotic Materials: Nacre



10-20 micron wide, 0.5 micron thick



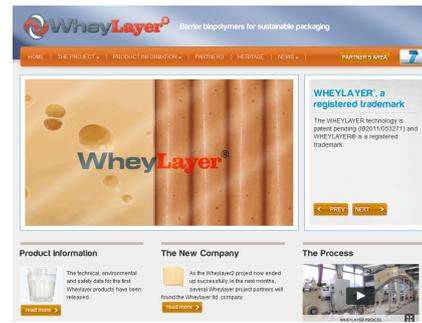
**Proteins Keeps
Hexagonal Aragonite Platelets
In-place**

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Milk Proteins as Plastics



<https://www.qmilkfiber.eu>



<http://www.wheylayer.eu>

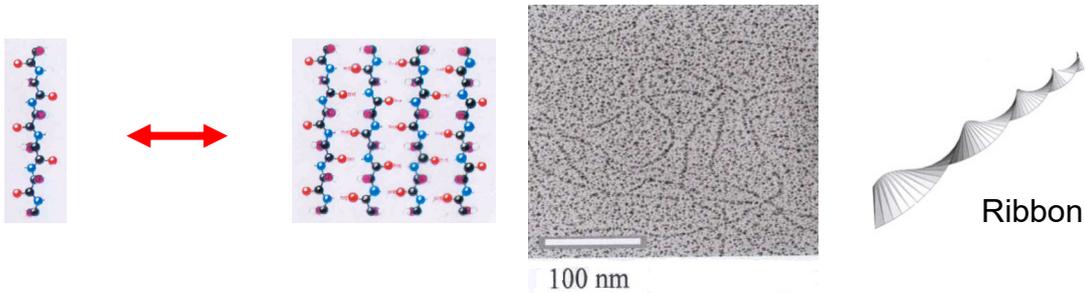
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Act 3



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A New Approach to Polymers

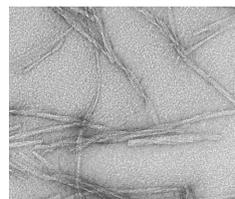
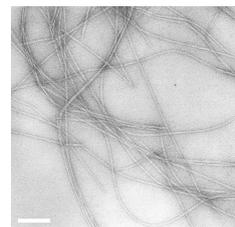
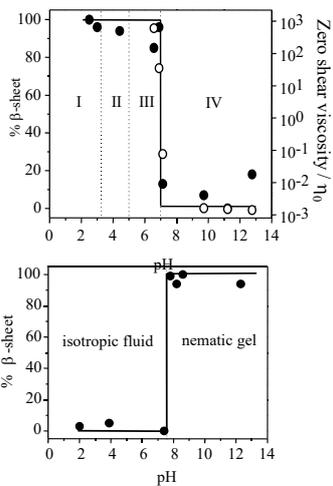
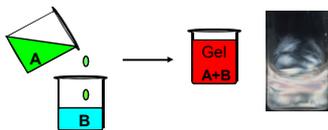


Highly cooperative H-bonds
Cross-strand attractive forces
Lateral recognition of adjacent beta-sheet strands

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Switchable Peptides

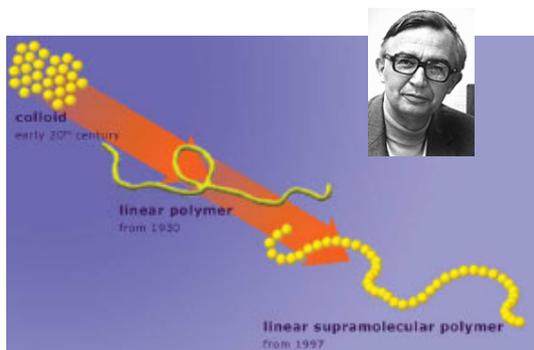
Triggered Fluidity



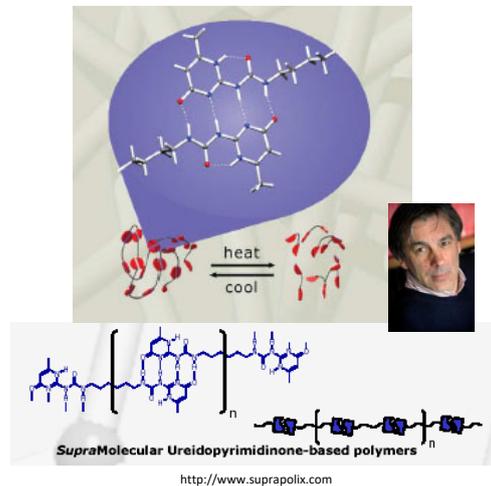
R. Koopmans (ed) Advances in Chemical Engineering Volume 35, Elsevier, 2009

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Apply Learnings from Nature

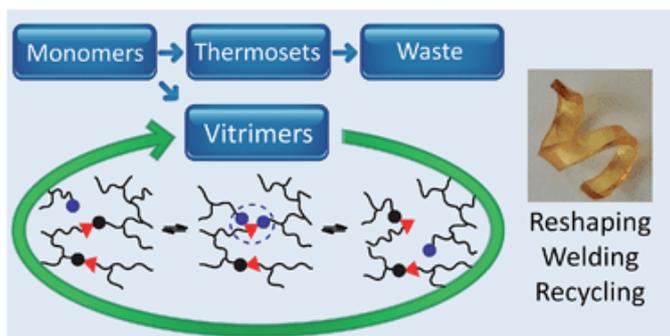


Source Pictures: Nobelprize.org – TUEindhoven <http://www.fna.phys.tue.nl/>



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Vitrimers



W. Denissen et al., Chem. Sci., 2016, 7, 30

https://www.espci.fr/en/directory?recherche=leibler&r_en_cours=on&type=recherche&unique_id=CgRcAjAeBDw%3D&lang=en



Ludwik Leibler
ESPCI – Paris (F)

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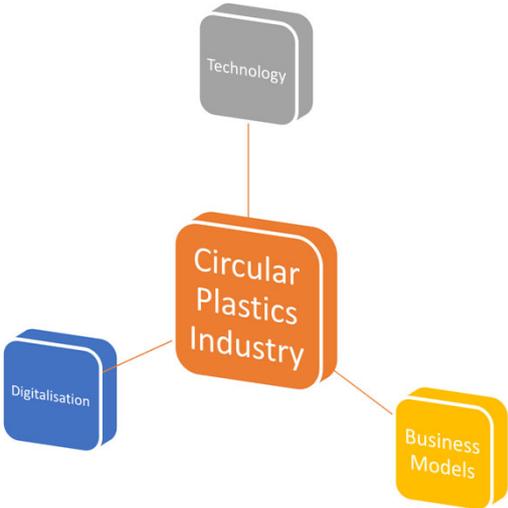
The Future is Now



Source: <https://gomobi.info/blog/mobile-is-the-future-and-the-future-is-now/>

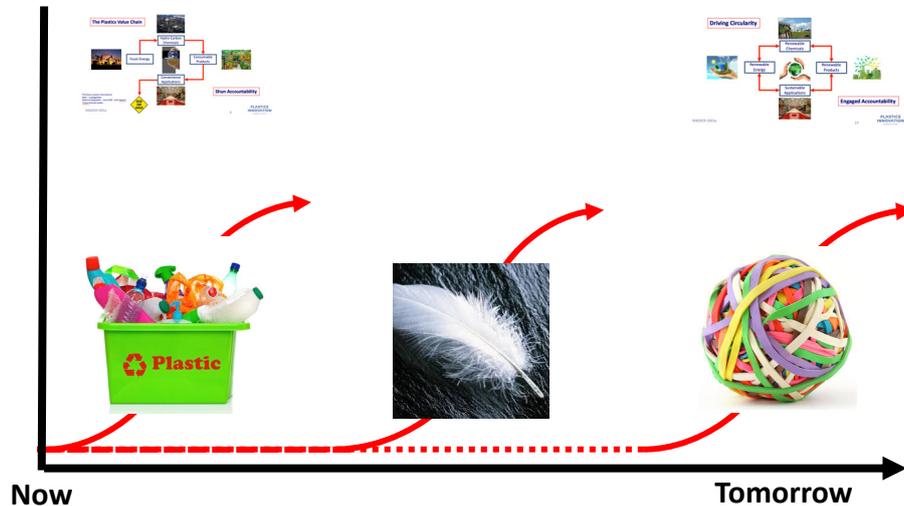
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The Future is Now



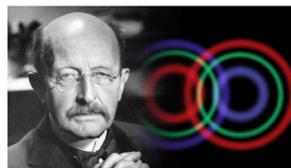
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The Future is Now



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A new scientific truth does not triumph by convincing its opponents and making them see the light but rather because its opponents eventually die and a new generation grows up that is familiar with.



Max Planck

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Hello

Think about my Future!



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