Not an Academic Exercise

The Greener Solutions Approach to Developing Safer Alternatives

International Symposium in Alternatives Assessment
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The Greener Solutions Process

Partner's challenge

Chemical Function

Understand design constraints

Identify alternatives

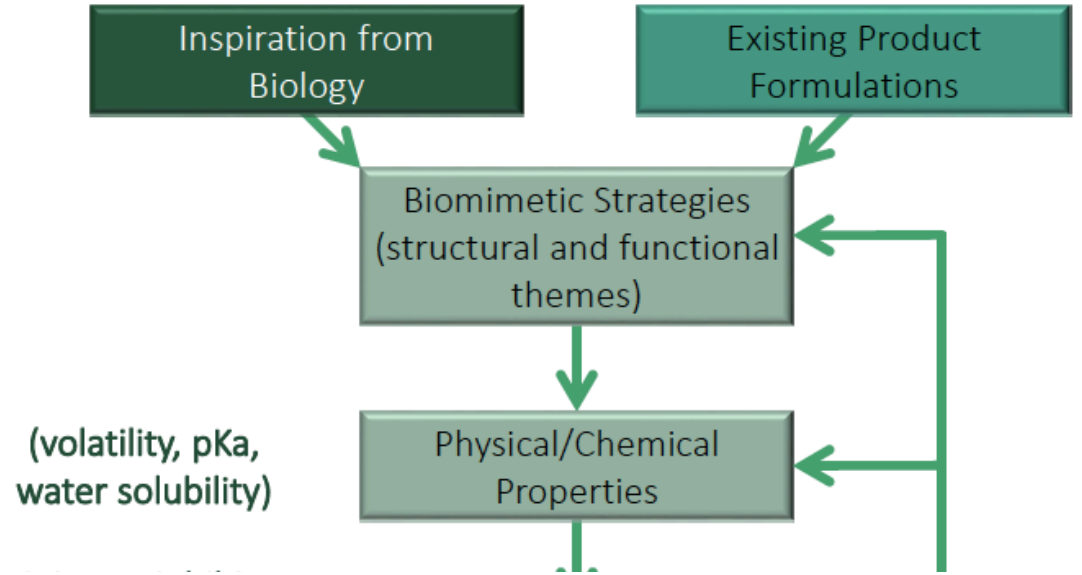
Evaluate alternatives

- Function
- Hazard

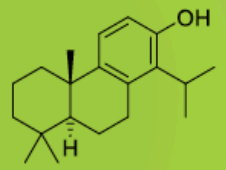
OPPORTUNITY MAP

BERKELEY CENTER FOR GREEN CHEMISTRY

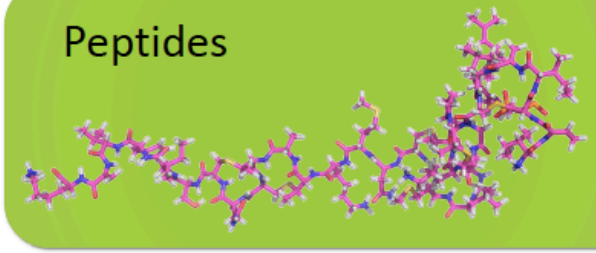
Iterative evaluation…



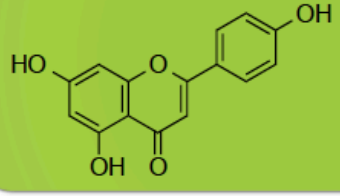
Terpenes



Peptides



Flavonoids



Fatty Acids

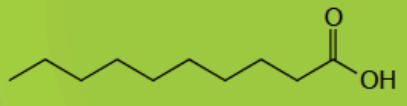
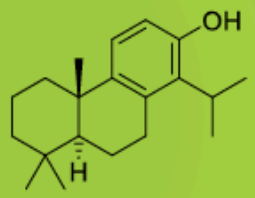


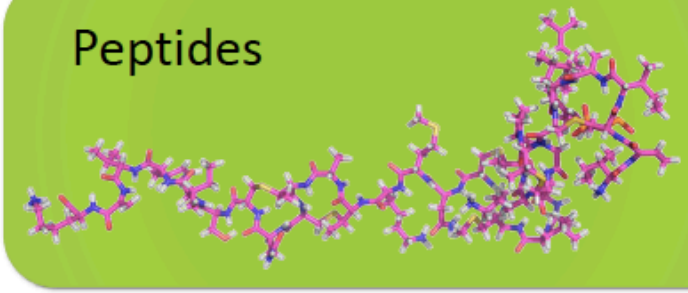
Image sources: en.wikipedia.org, examiner.com, naturesbounty.ca

Bioinspired Antimicrobials

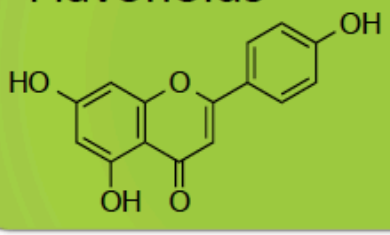
Terpenes



Peptides



Flavonoids



Fatty Acids

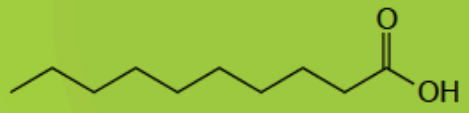


Image sources: en.wikipedia.org, examiner.com, naturesbounty.ca

Assessment Criteria

Table 7.3. Scoring guidelines for multi-criteria evaluation framework.

Performance Criteria	Score		
	3	2	1
Hazard	Low hazard level for most non-DG endpoints AND no endpoints with high hazard level	Medium hazard level for most non-DG endpoints OR roughly equal numbers of high and low hazard levels	High hazard level for most non-DG endpoints AND more medium than low hazard levels for remaining endpoints
Antimicrobial Efficacy	Average of efficacy scores = 3	Average of efficacy scores = 2-3	Average of efficacy scores = 1-2
Level of Uncertainty	Number of safety data gaps = 0-3	Number of safety data gaps = 4-8	Number of safety data gaps = 9+
Biodegradability	Low hazard level for persistence	Medium hazard level for persistence	High hazard level for persistence
Origin of Raw Materials	Natural source is available and comparably priced or cheaper than synthetic alternative	Natural source is available but much more expensive than synthetic alternative	Only synthetic options are available
Product Compatibility	Already used in product as a preservative OR expected to perform optimally in existing products with minimal (or no) changes to formulation	Expected to perform well in existing products with small changes in formulation	May be unsuitable for some products OR may require major changes to formulation to perform well
Regulatory Concerns	Already approved for use as a preservative by FIFRA or has exempt status	Has precedent for approval for other uses OR is a good candidate for FIFRA exempt status OR has additional requirements but not restrictions	Ingredient is banned or has limits on maximum allowable concentration
Cost	$0-20/kg (irrespective of source, i.e. natural or synthetic)	$20-50/kg (irrespective of source, i.e. natural or synthetic)	$50+/kg (irrespective of source, i.e. natural or synthetic)

Multi-criteria assessment of potential alternative antimicrobials

Table 7.5. Multi-criteria evaluation framework for Beautycounter.

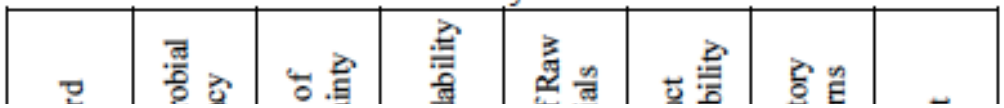


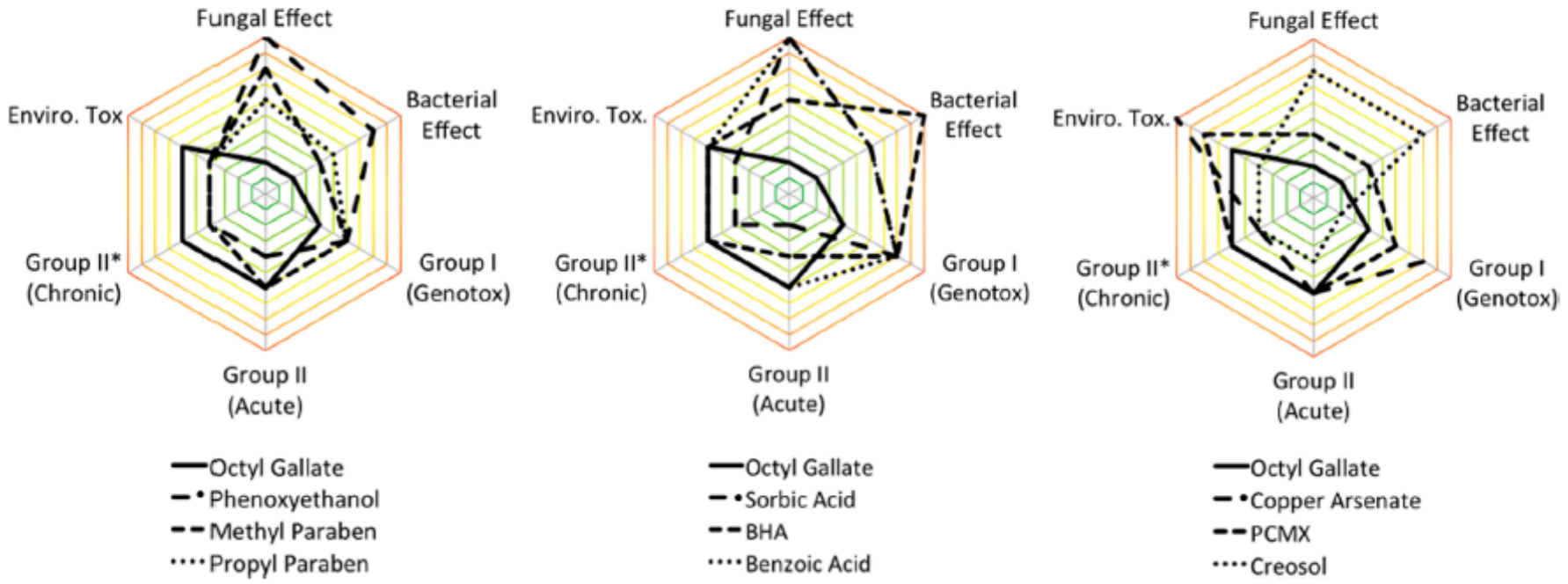
Table 7.6. Multi-criteria evaluation framework for Seventh Generation.

	Hazard	Antimicrobial Efficacy	Level of Uncertainty	Biodegradability	Origin of Raw Materials	Product Compatibility	Regulatory Concerns	Cost
Terpenes	1	2	2	2	3	3 1	3	2
Peptides	3	2	1	3	3	1	2	1
Flavonoids	2	2	2	2	3	1	2	1
Lipids	2	2	2	3	3	2	2	3
Methyliso-thiazolinone	1	2	3	2	1	3	3	3

Higher number/darker color = more favorable

Hazard and effectiveness of octyl gallate relative to common commercial preservatives

ACS Sustainable Chemistry & Engineering Research Articl



Home and personal care products

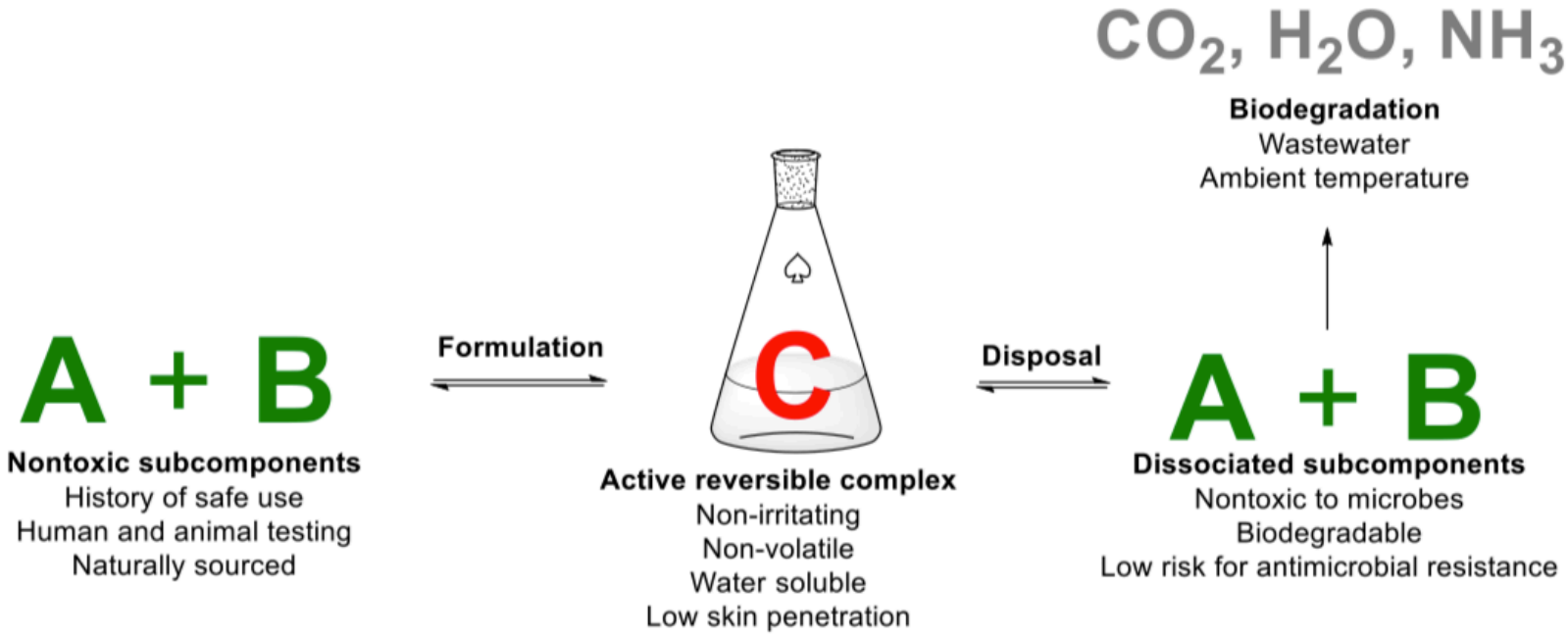
Food packaging

Building materials

Smaller values (closer to the center) indicate better performance for that metric

Buckley et al. ACS Sustainable Chem. Eng. 2017, 5, 4320−4331

And the work continues…



From William Hart-Cooper, USDA

Integrating assessment of hazard and efficacy

- Elevates safety in design criteria
- Generates novel ideas

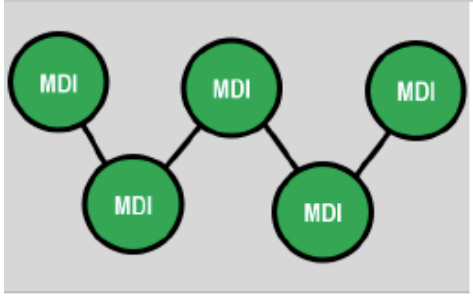
Safer Spray-Foam Insulation

Jeremy Faludi
Mechanical Engineering

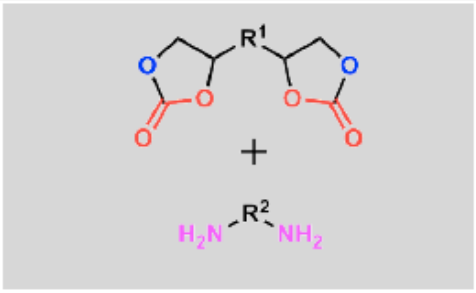
Patrick Gorman
Chemistry

Tina Hoang
Environmental Health

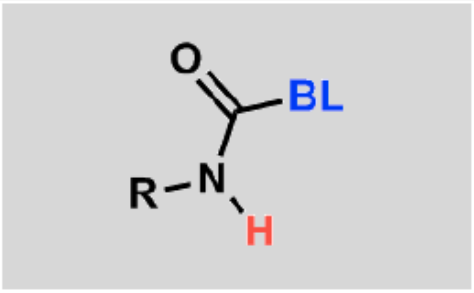
image from sprayfoam.org



Polymeric MDI



Non-Isocyanate Polyurethane



Blocked Isocyanates

Foamed Concrete

Alternatives

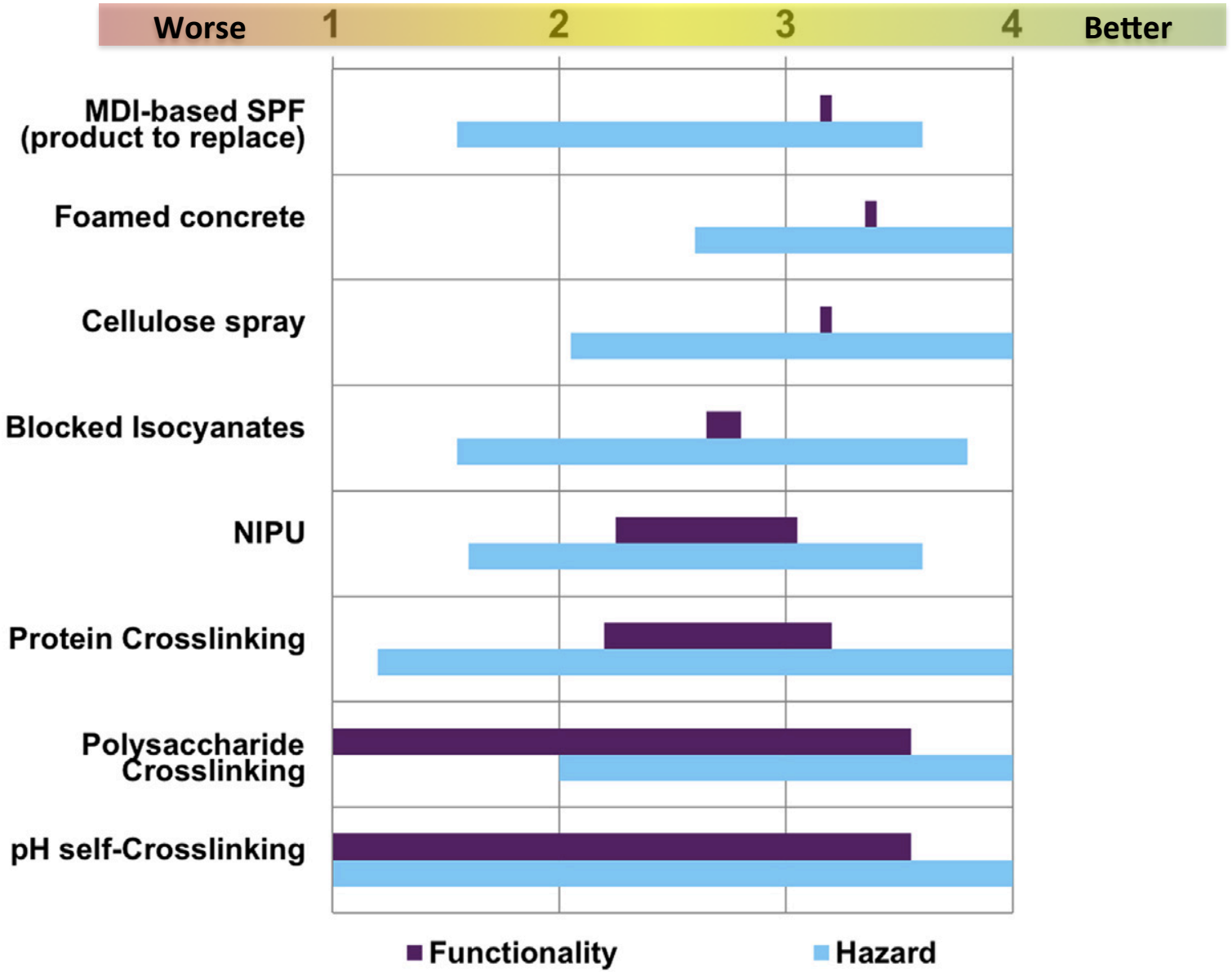
Cellulose Spray

Protein Crosslinking

Polysaccharide Crosslinking

pH self-crosslinking

Summary of Hazard and Function of SPF Insulation and Alternatives



J. Faludi et al. / Journal of Environmental Management 182 (2016) 111e125

Alternatives to fluorine-based DWR textile coatings

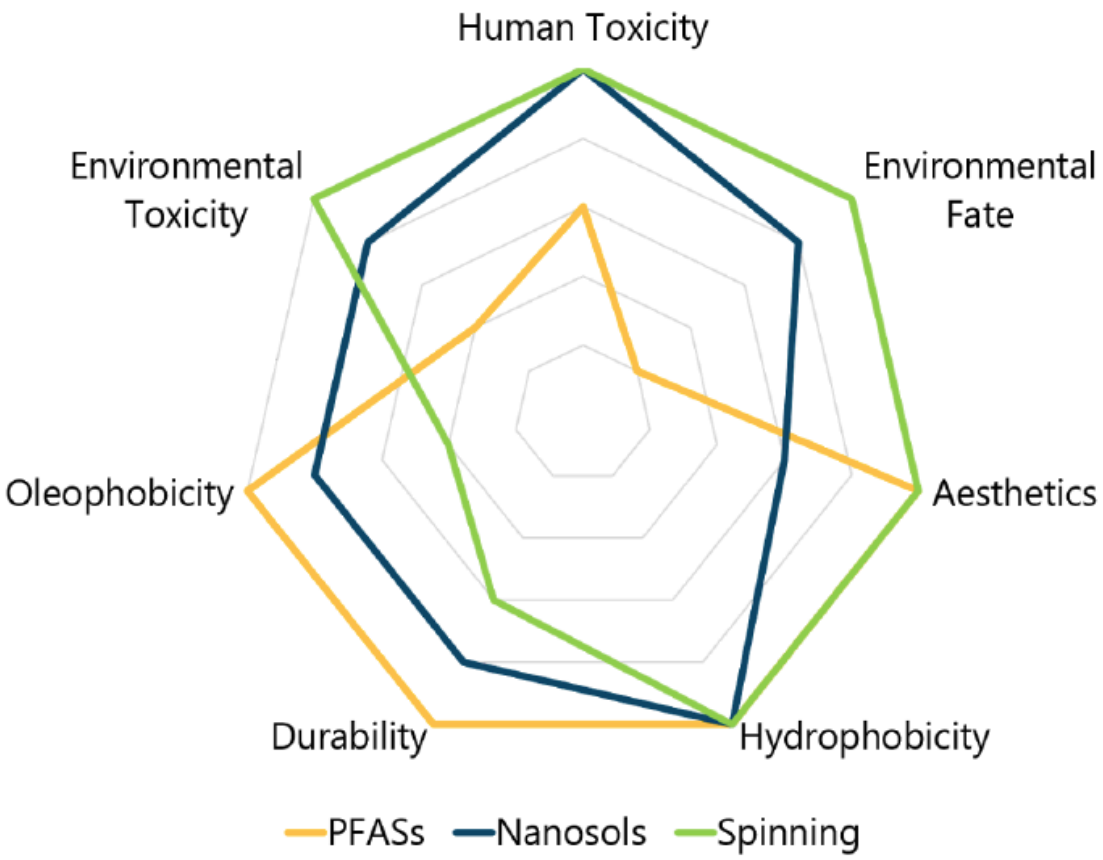


Fig. 5.1. Relative hazard and performance comparison between PFAS and the two alternatives presented in this report. A strategy is better performing if its endpoints lie closer to the outer ring of the chart. More hazardous and poorer performing alternatives will score closer to the center.

Silver ragwort leaf inspiration for electro-spun fiber mat

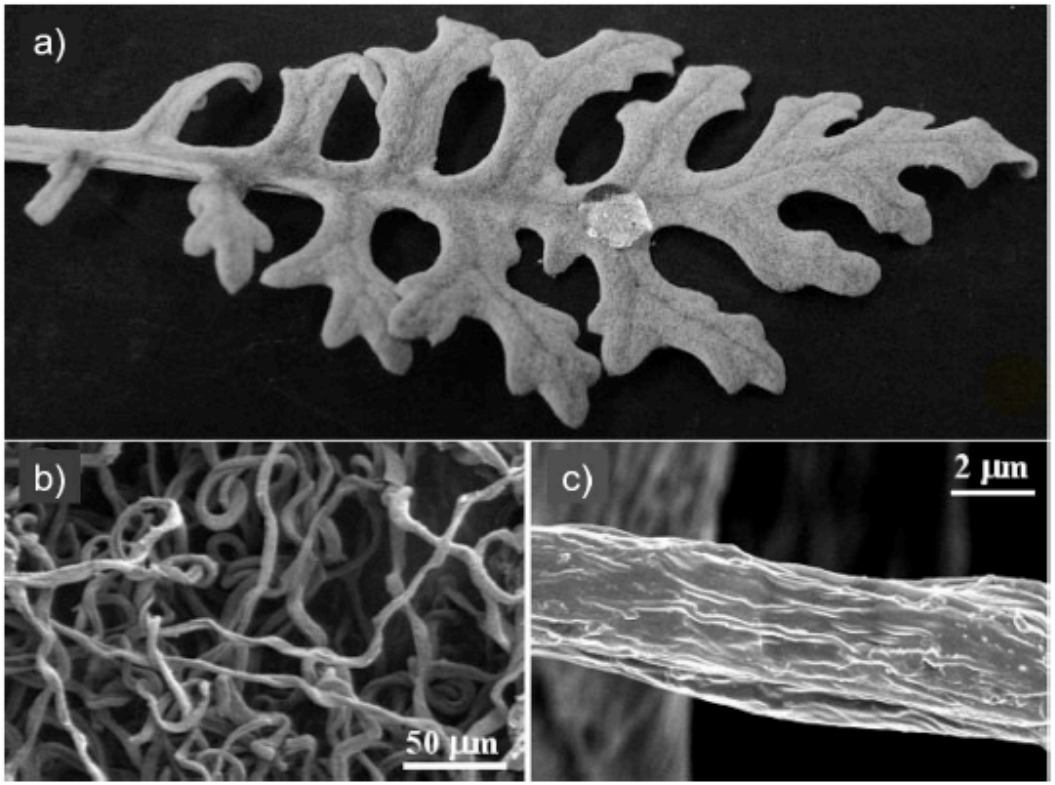
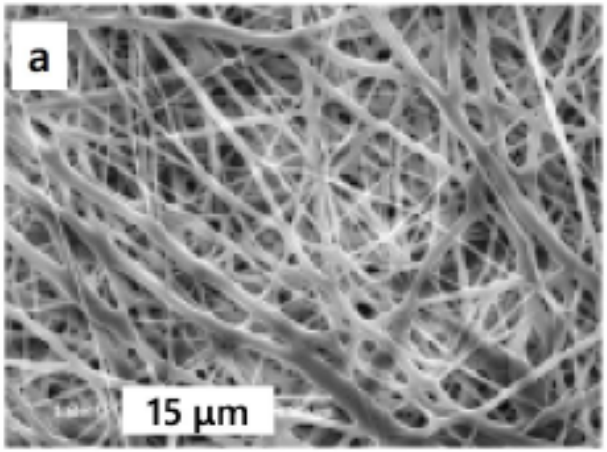
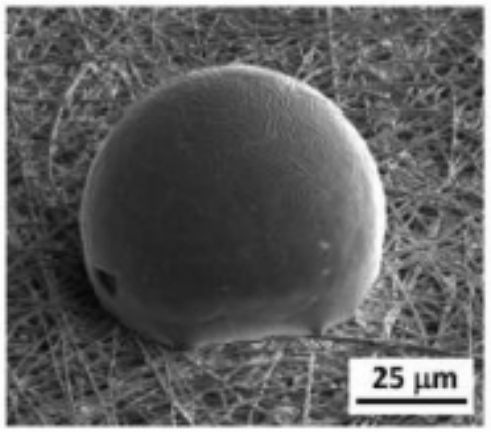


Fig. 4.13. Silver ragwort leaf. a) Digital photograph of a leaf with a beaded water droplet. b) and c) SEM images showing the tangle of fibers and the structuring on the fibers.





UC Berkeley - Greener Solutions

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