A Circular Economy for Plastics

Brett A. Helms
Lawrence Berkeley National Laboratory

Mariana Trench, February 2019
Source: The Guardian

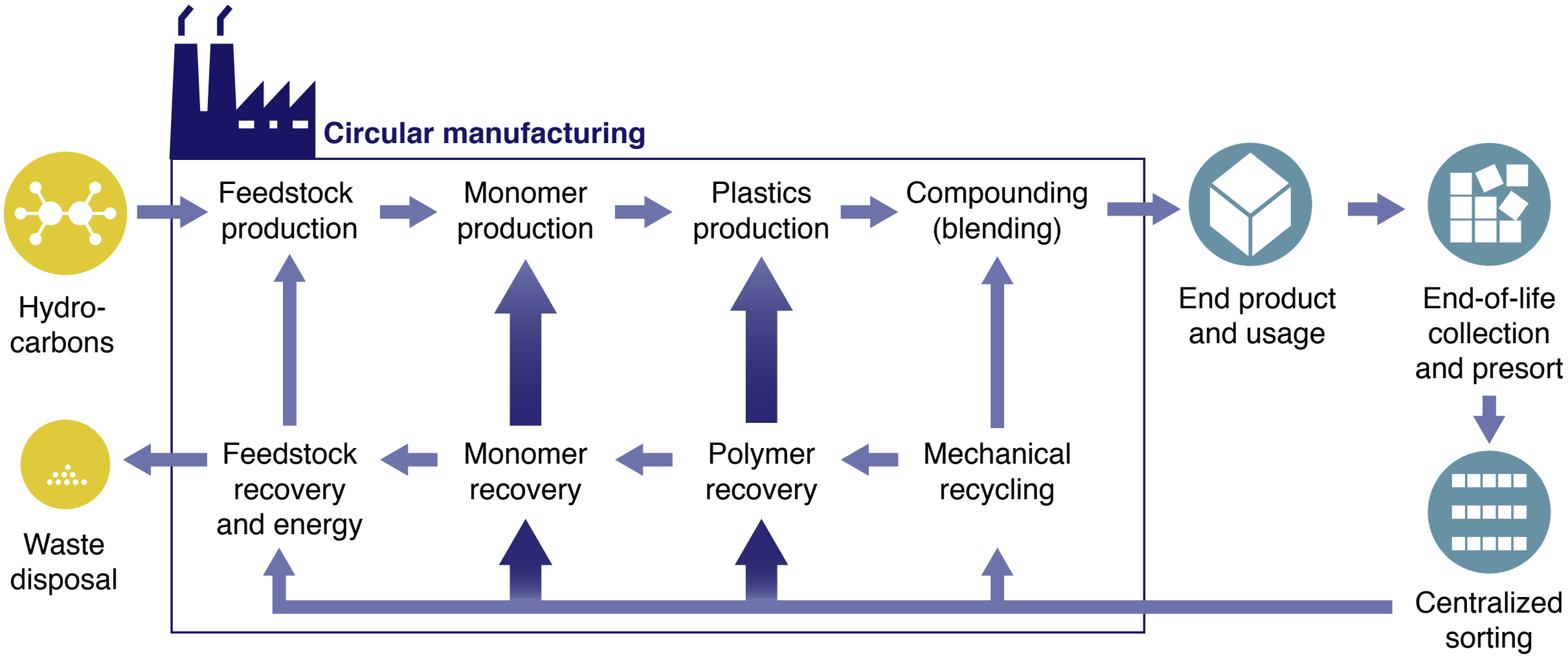
The Arctic, August 2019
Source: The Guardian

Bergmann, et al. Sci. Adv. **5**, eaax1157 (2019)

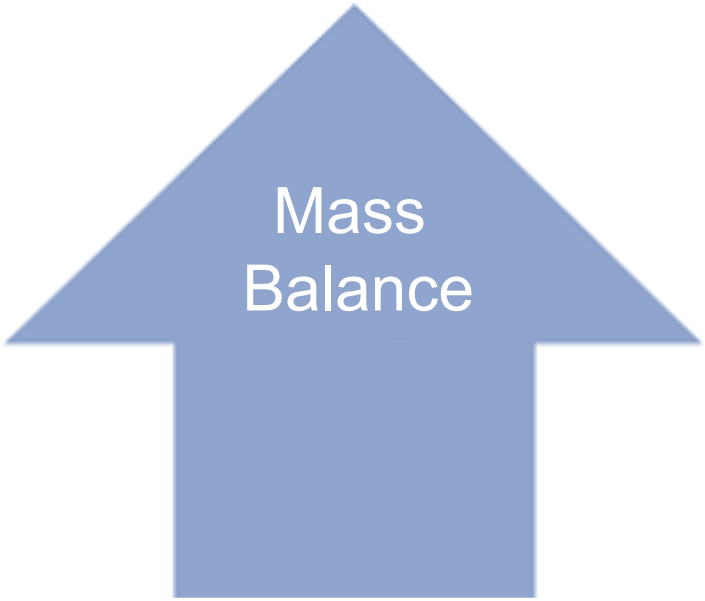
Goal: Zero Discharge

© 2016 Tane Sinclair-Taylor / tanesinclair-taylor.com

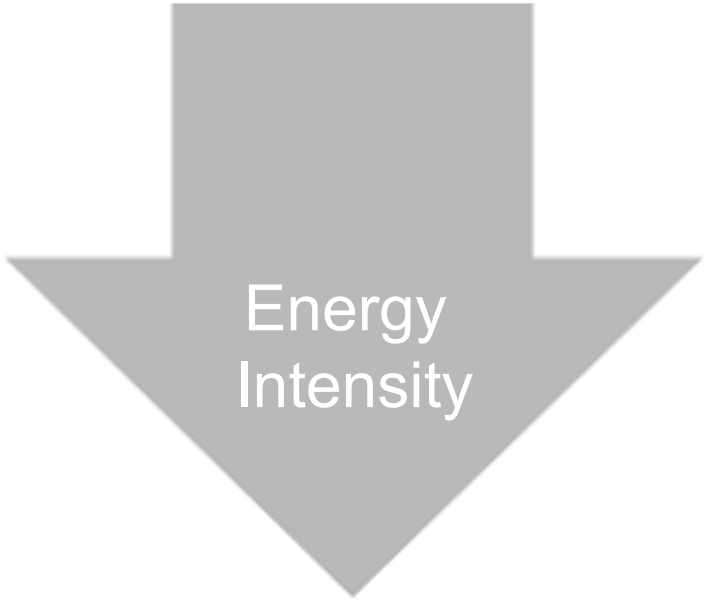
Enabling the Circular Economy for Plastics



Outstanding Challenges in Circular Manufacturing



Losses in chemical recycling of conventional plastics can be >30%

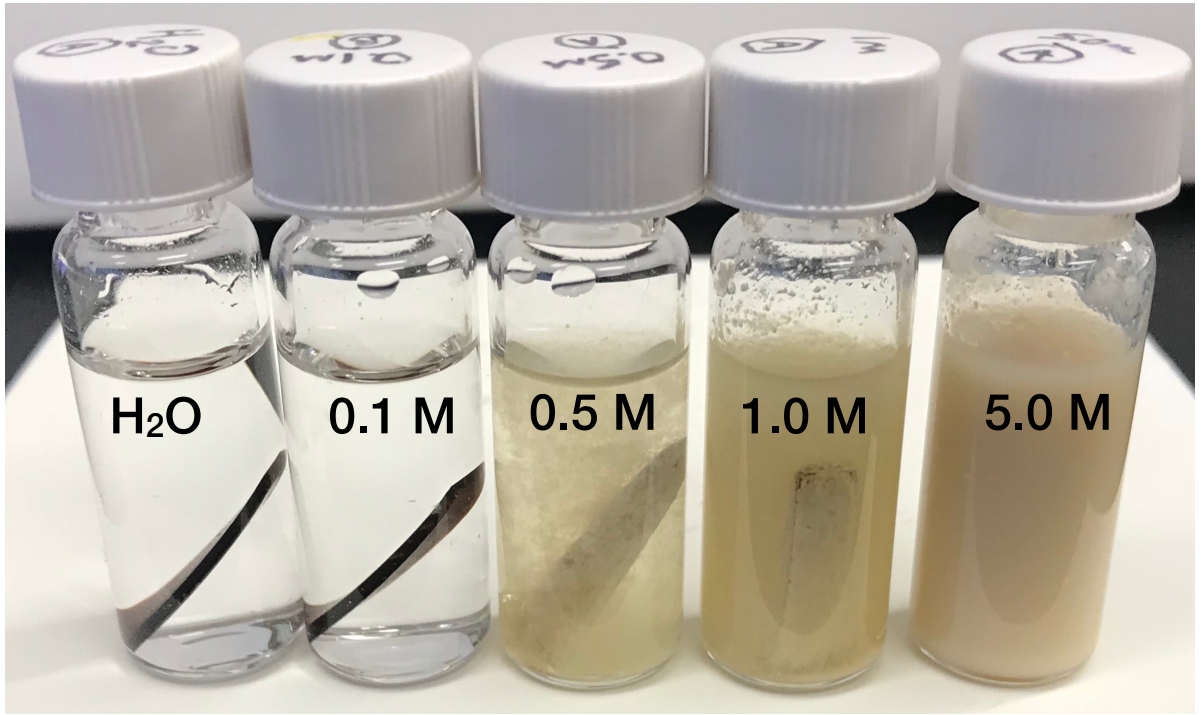


Energy intensive pyrolysis and gasification processes can be costly to implement without tax offsets

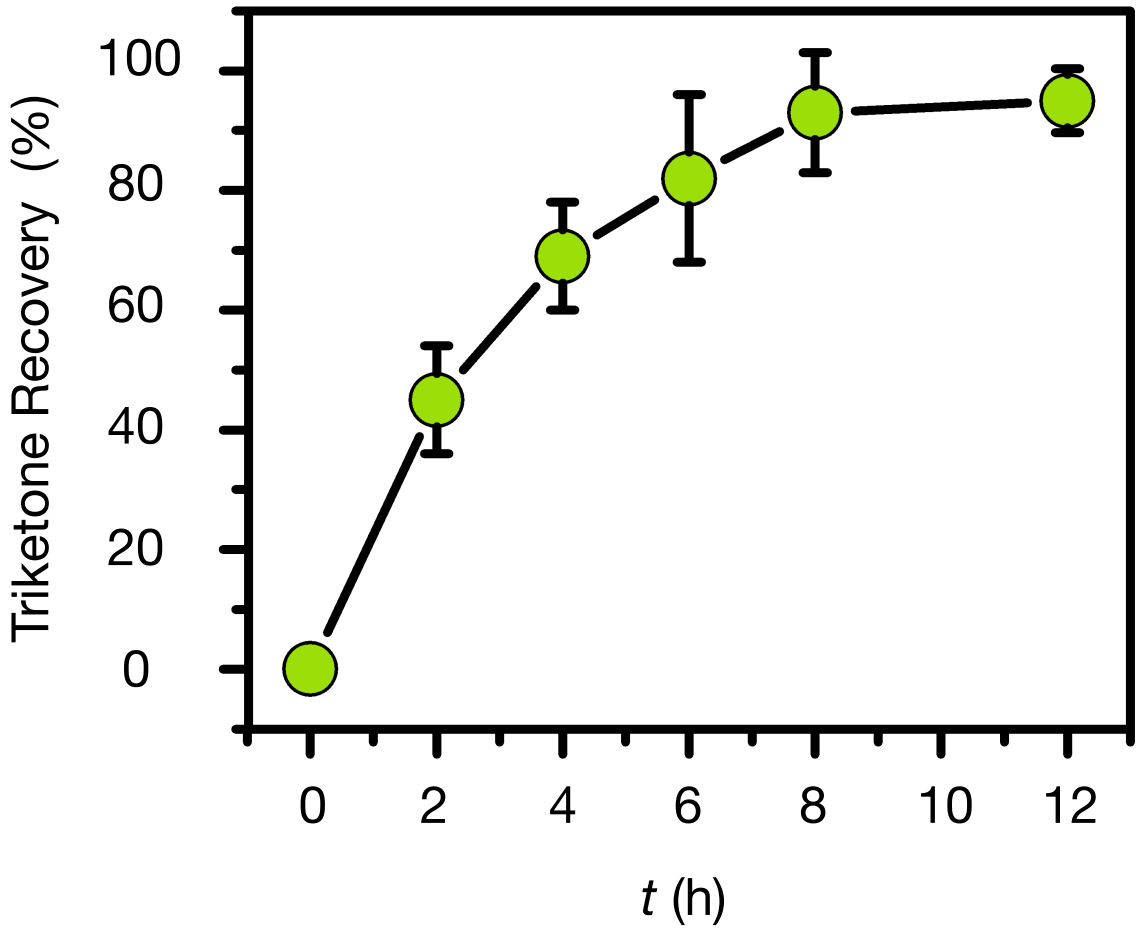
Depending on the process, emissions can be on par with primary resin production

Chemistry Unlocks Circularity in Plastics Recycling

Berkeley Lab's PDK Plastics Innovation Leads on Efficiency of Chemical Recycling

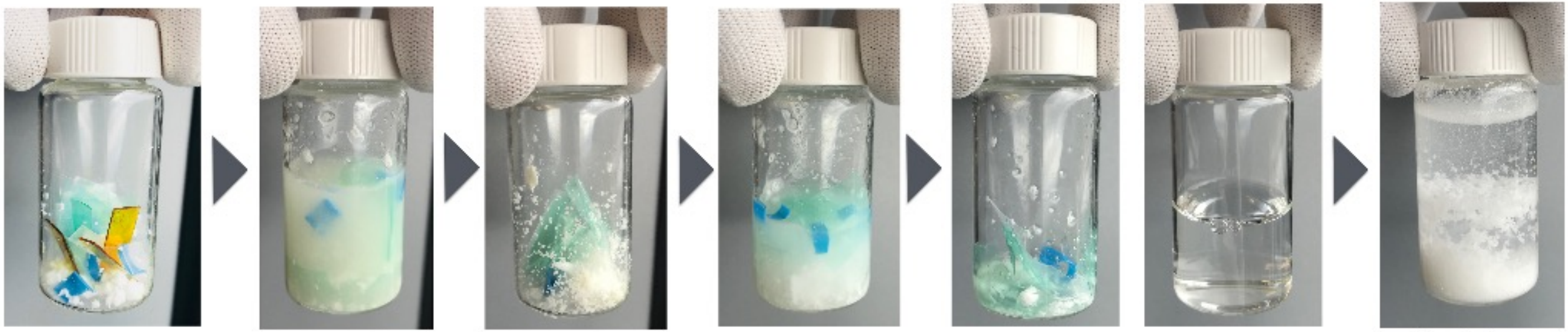


H_2SO_4, 25 ˚C, 24 h

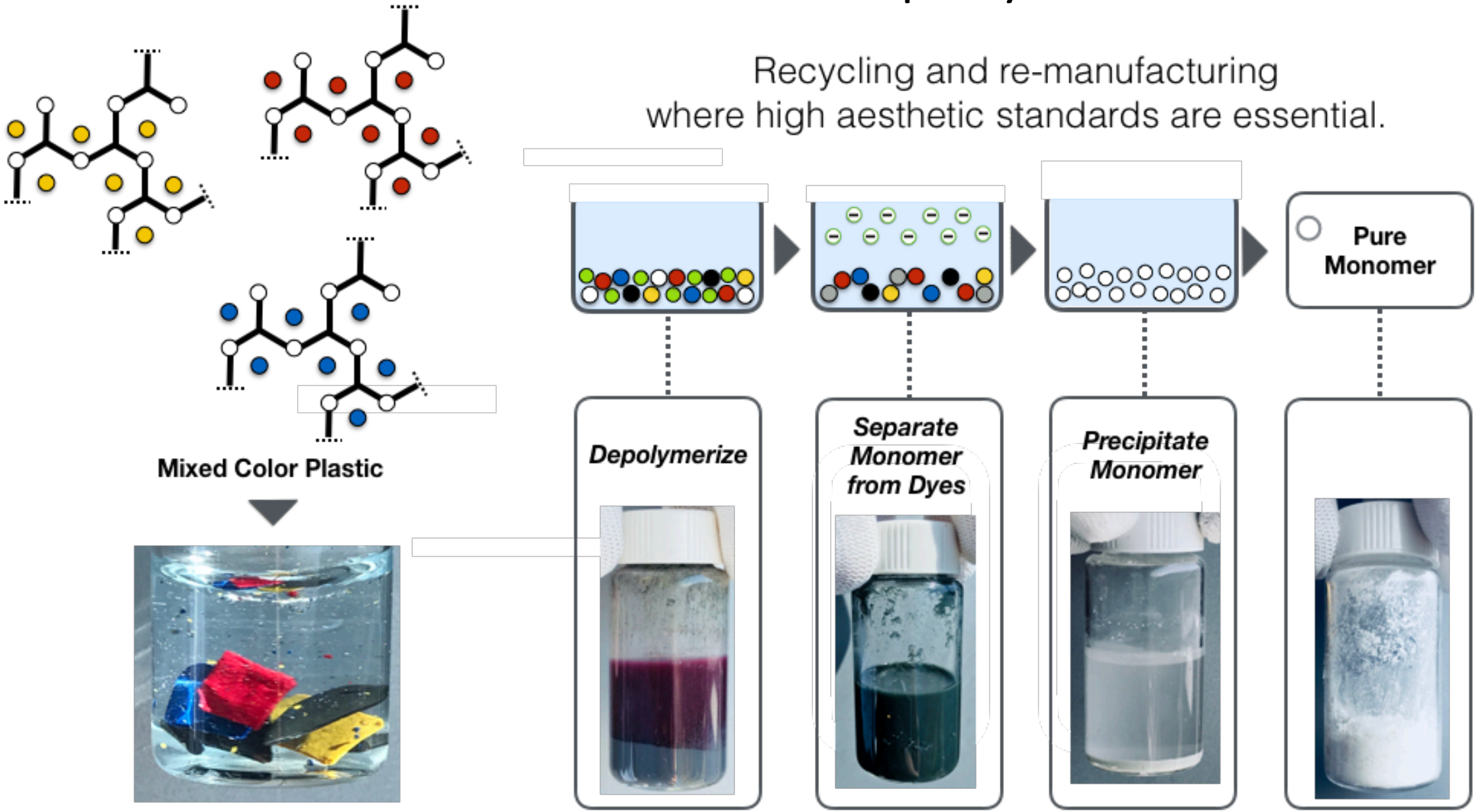


Chemical Recycling Possible Even in Mixed Waste

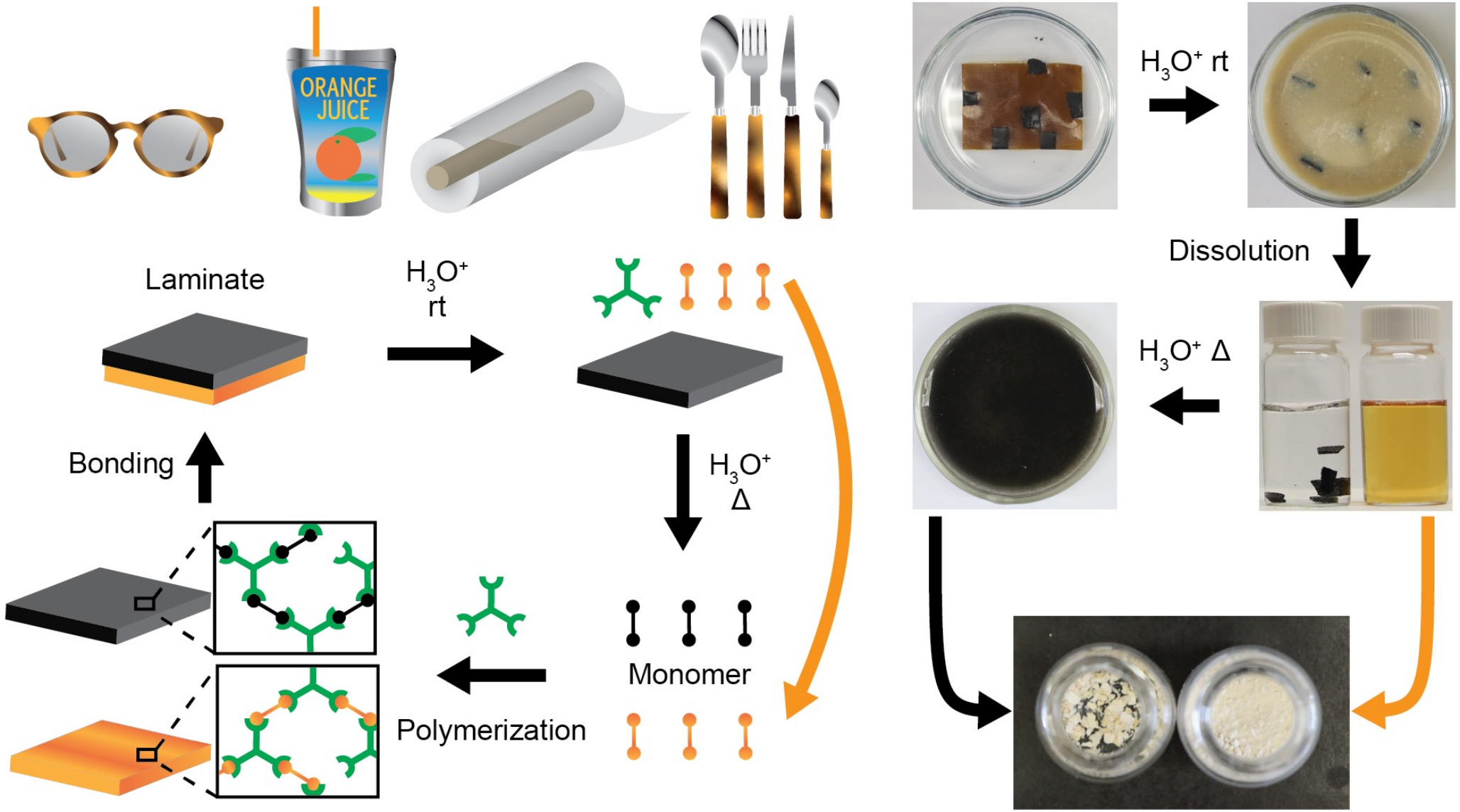
Mixed Plastic Waste ▶ **Selective Catalytic Depolymerization** ▶ **Chemical Separations and Resource Recovery** ▶ **Pristine Monomer**



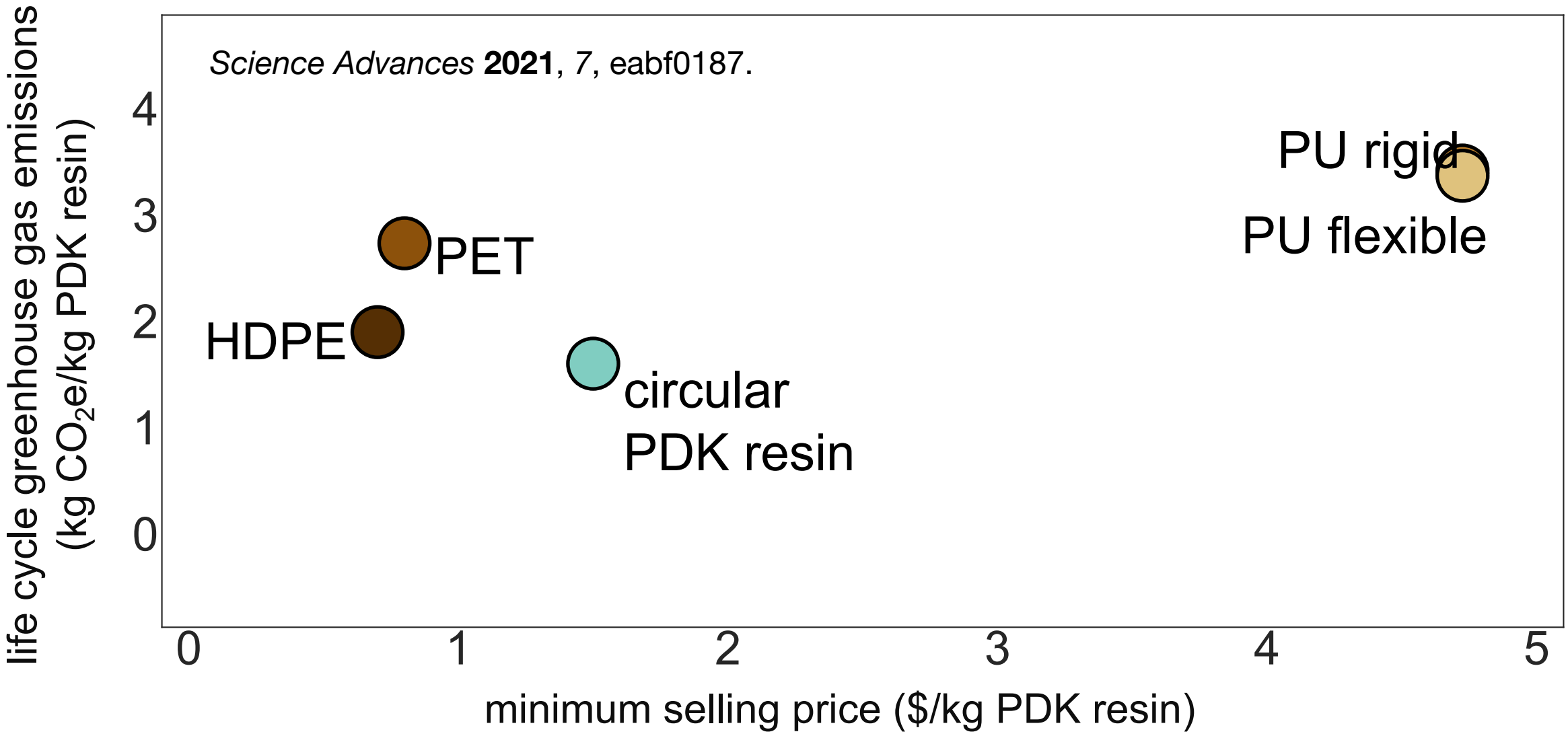
Decoloration of PDK After Depolymerization



Chemical Recycling of Mixed-Plastic Waste



Circularity Reduces Harms and Appears Market-Ready



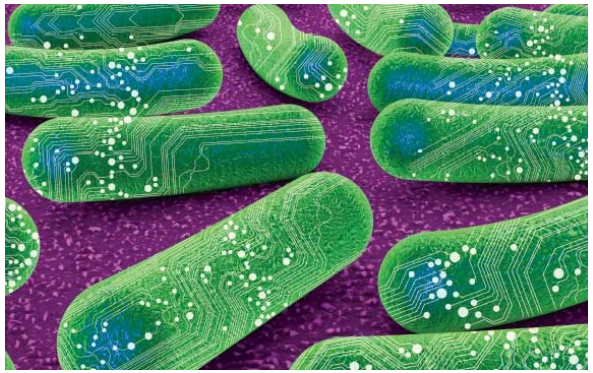
Directions Under Development at Berkeley Lab

Sustainability of Supply Chains

Petrochemicals

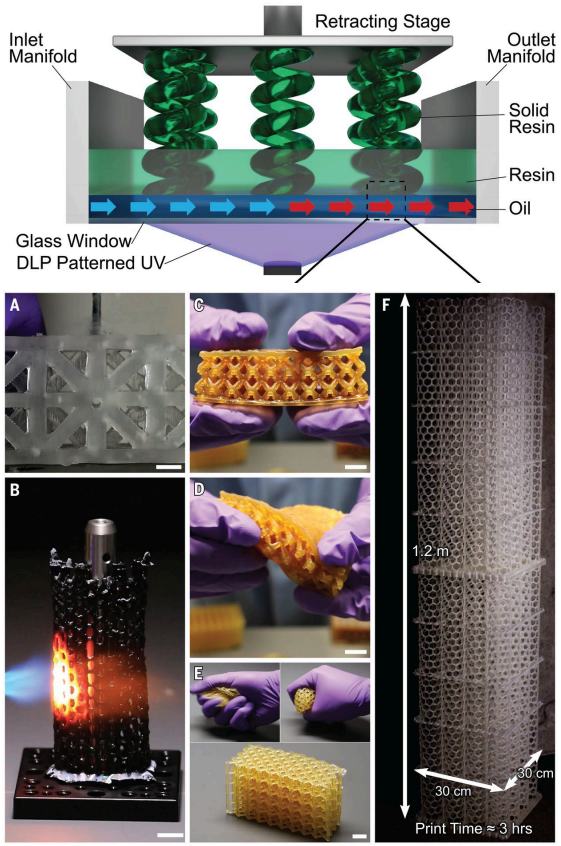
Waste to Monomer

Biomass

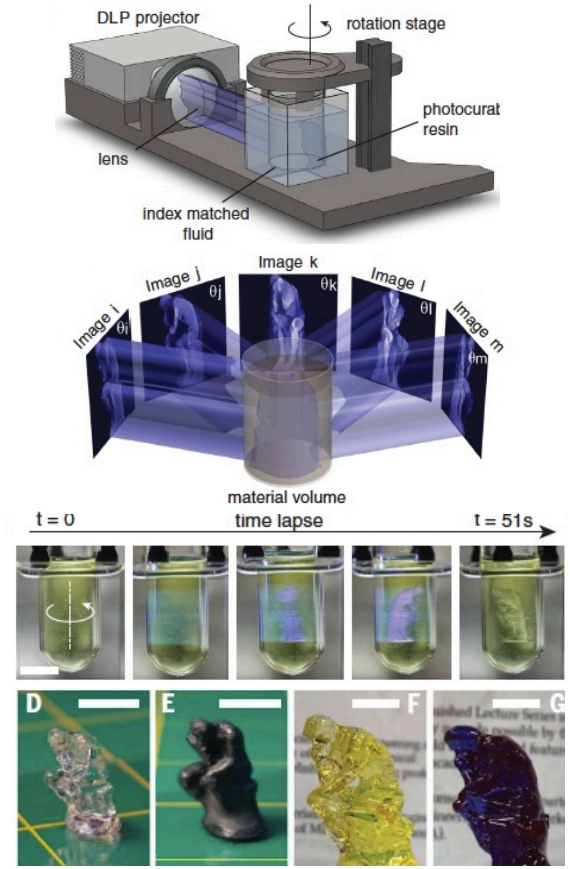


Synthetic Biology

Aligned with Future Manufacturing



Continuous 3D Printing



Volumetric 3D Printing

Science **357**, 1242 (2017); *Science* **360**, eaas9793 (2018); *Science* **363**, 1075 (2019); *Science* **366**, 360 (2019).