ARKEMA

2e Session Nouveaux procédés de production de grands intermédiaires.

14h00 - 14h30 Les acrylates (Acrylonitrile et Acides (meth)acryliques).
Jean-Luc DUBOIS, Directeur Scientifique • Arkema

Les Acrylates

Acrylonitrile et Acides (Meth)Acryliques

Jean-Luc DUBOIS

Process selection may depend on local feedstock availability.

Europe:
Crude Oil/Naphtha

North America:
Shale Gas & Liquids

Middle East:
Oil & Gas

China: Coal

South America:
Biomass

South East Asia:
Biomass

catalysts

MDPI

Review

Review on Alternative Route to Acrolein through Oxidative Coupling of Alcohols

Vincent Folliard [1,*], Jacopo de Tommaso [2] and Jean-Luc Dubois [2,*]

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[2] Arkema France, Corporate R&D, 420 Rue d'Estienne d'Orves, 92705 Colombes, France; jacopo.de-tommaso@arkema.com
* Correspondence: vincent.folliard@ircelyon.univ-lyon1.fr (V.F.); jean-luc.dubois@arkema.com (J.-L.D.); Tel.: +33-472-398-511 (J.-L.D.)

Acrylic Acid

ELSEVIER

Journal of Molecular Catalysis A: Chemical 220 (2004) 67–76

A: CHEMICAL

www.elsevier.com/locate/molcata

Strategy in achieving propane selective oxidation over multi-functional Mo-based oxide catalysts

hem. Eng. Technol. **2009**, *32*, No. 3, 1–8

ntoine Godefroy[1]
regory S. Patience[1]
ania Tzakova[1]
ominque Garrait[2]
ean-Luc Dubois[2]

Research Article

Reactor Technologies for Propane Partial Oxidation to Acrylic Acid

Catalysis Communications 17 (2012) 23–28

Contents lists available at SciVerse ScienceDirect

Catalysis Communications

journal homepage: www.elsevier.com/locate/catcom

ELSEVIER

Short Communication

Influence of surface acid–base properties of zirconia and titania based catalysts on the product selectivity in gas phase dehydration of glycerol

Green Chemistry

PAPER

View Article Online
View Journal | View Issue

CrossMark click for updates

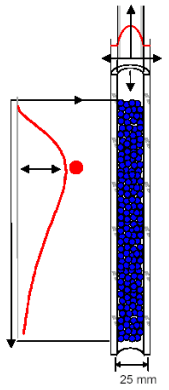
Cite this: *Green Chem.*, 2015, **17**, 343

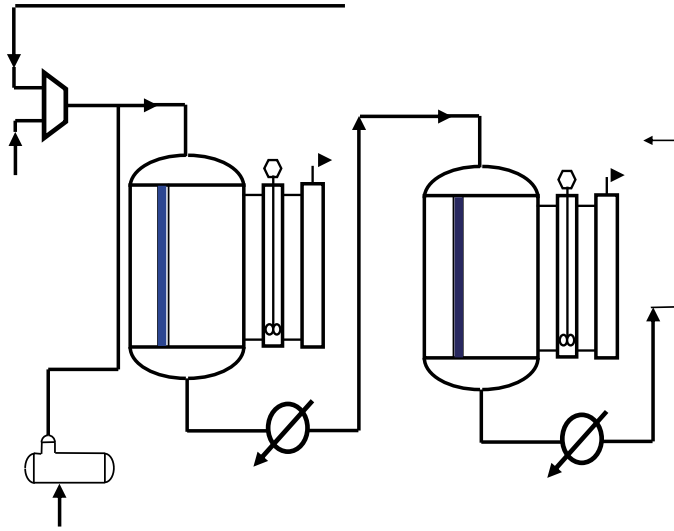
Glycerol as feedstock in the synthesis of chemicals: a life cycle analysis for acrolein production†

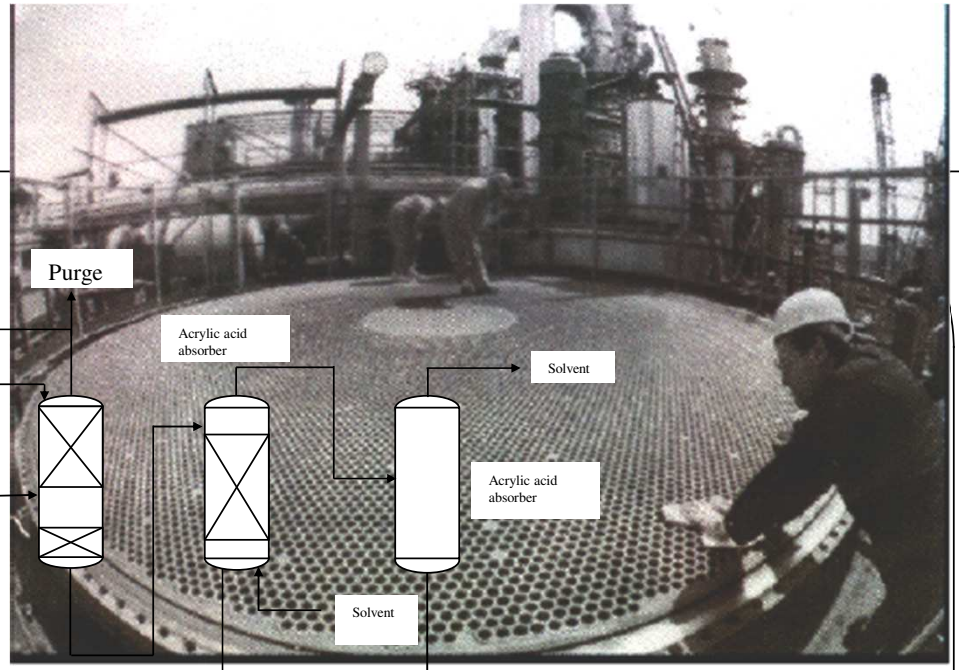
D. Cespi,[a] F. Passarini,*[a,b] G. Mastragostino,[a] I. Vassura,[a,b] S. Larocca,[c] A. Iaconi,[d]

Conventionnal Propylene oxidation process
Multitubular Fixed Bed Reactors

Hot spot





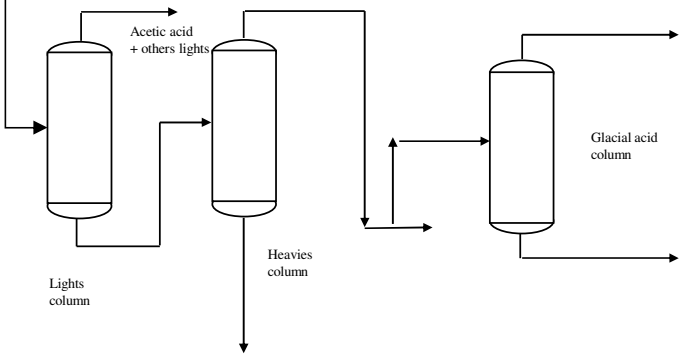


Acrolein reactor fabrication

Number of tubes: > 27.000
Weight: 350 MT

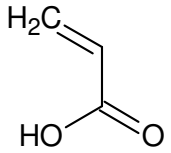
Acrylic acid reactor

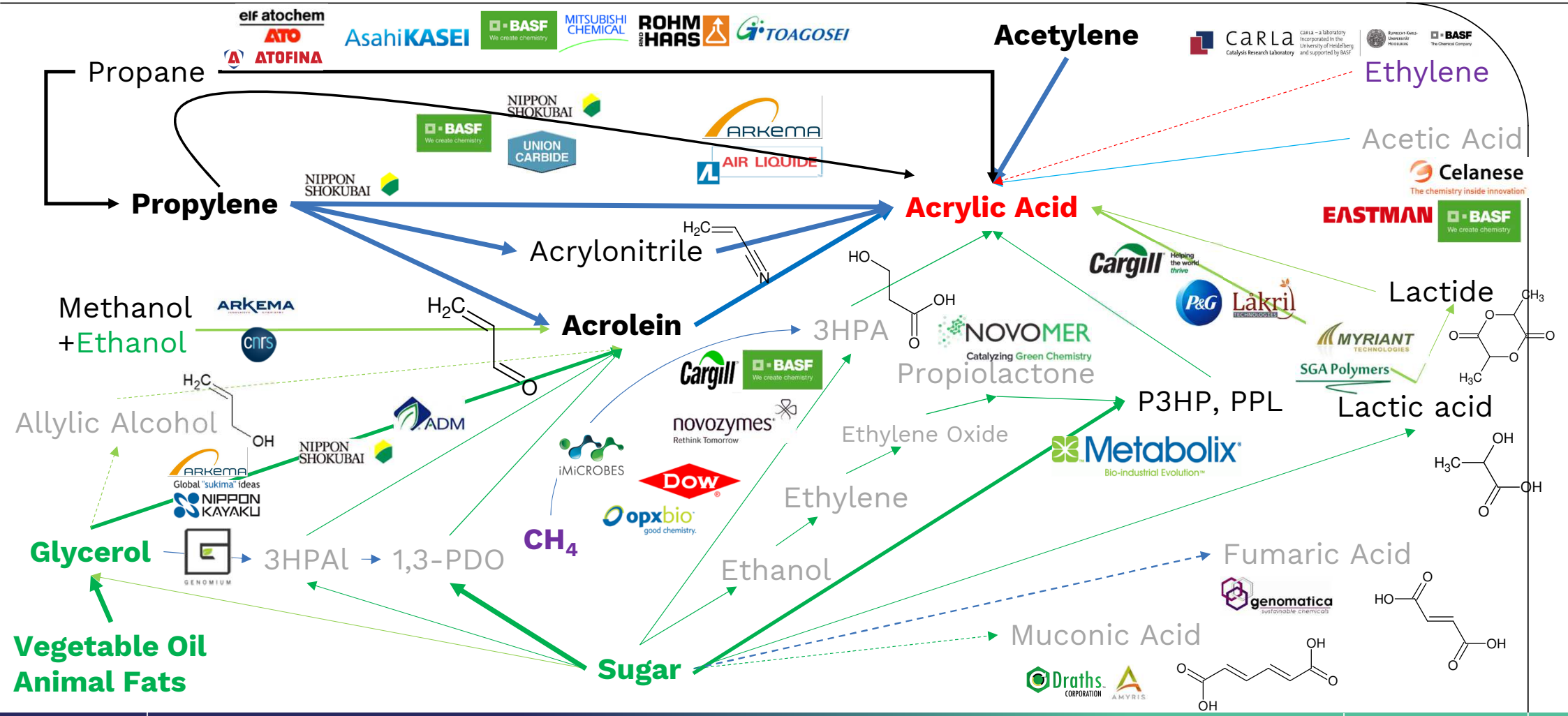
Number of tubes > 27.000
Weight: 570 MT



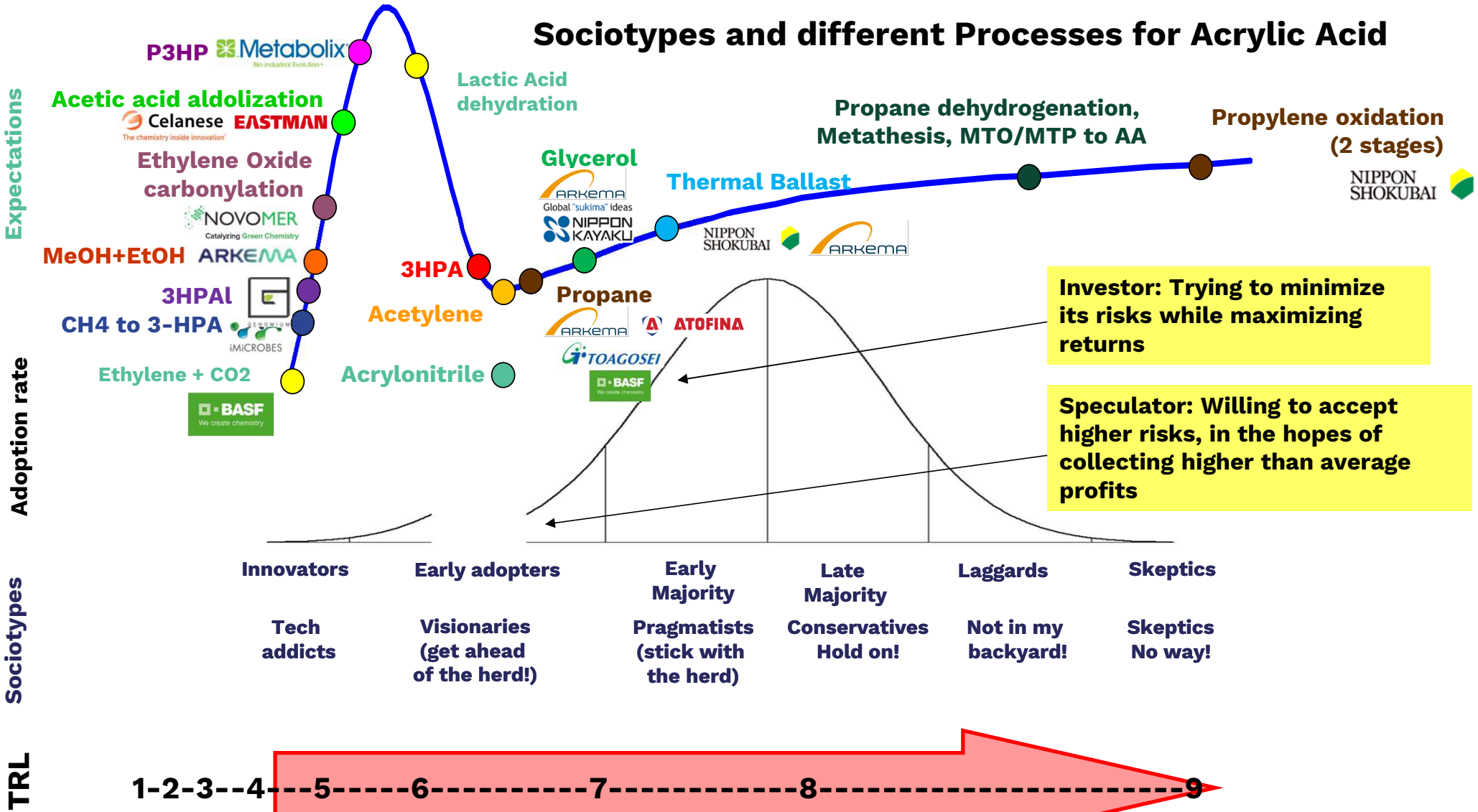
Multitubular fixed bed reactors @ dwe.com

Acrylic Acid

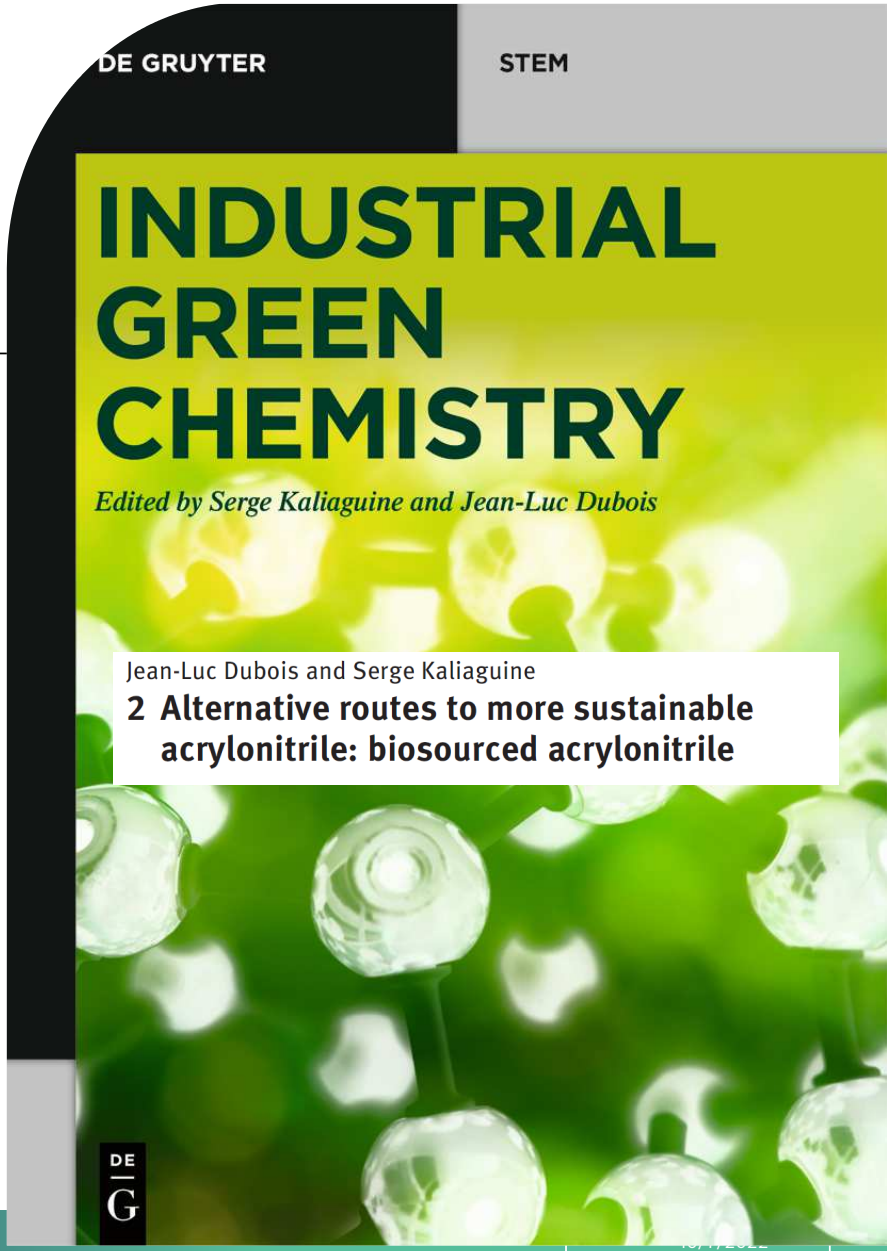




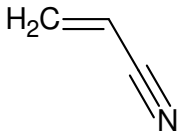
Sociotypes and different Processes for Acrylic Acid



Acrylonitrile



Acrylonitrile



Acetone

Isopropanol

PYROCO2

Propylene

Methanol

Ethylene Oxide

Ethylene CyanHydrine

Acetaldehyde

Acetylene

Ethylene

Propiolactone

Lactonitrile

Natural gas / Biogas / CO_2

NOVOMER Catalyzed Chemistry

Ethanol

PPL

P3HP

AsahiKASEI

Propane

Sugar

3-HPA

Acrylonitrile

Glutamic Acid

TRILLIUM

3-Hydroxypropionamide

CO_2

VERDANT

Glycerol

Acrolein

ARKEMA

Allylic Alcohol

Propylene Glycol

Hydrogenated liquids

Vegetable oils
Animal Fats

Pyrolysis Liquids ← Wastes

Methacrylic Acid/ Methyl ester

Chem Soc Rev

REVIEW ARTICLE

View Article Online
View Journal

Check for updates

Cite this: DOI: 10.1039/c8cs00117k

Catalysis for the synthesis of methacrylic acid and methyl methacrylate†

Mohammad Jaber Darabi Mahboub, [a] Jean-Luc Dubois, [b] Fabrizio Cavani, [c] Mohammad Rostamizadeh [d] and Gregory S. Patience [a]

Methyl methacrylate (MMA) is a specialty monomer for poly methyl methacrylate (PMMA) and the increasing demand for this monomer has motivated industry to develop clean technologies based on renewable resources. The dominant commercial process reacts acetone and hydrogen cyanide to MMA (ACH route) but the intermediates (hydrogen cyanide, and acetone cyanohydrin) are toxic and represent an environmental hazard. Esterification of methacrylic acid (MAA) to MMA is a compelling alternative together with ethylene, propylene, and isobutene/t-butanol as feedstocks. Partially oxidizing isobutane or 2-methyl-1,3-propanediol (2MPDO) over heteropolycompounds to MAA in a single-step is nascent technology to replace current processes. The focus of this review is on catalysts and their role in the development of processes herein described. Indeed, in some cases remarkable catalysts were studied that enabled considerable steps forward in both the advancement of catalysis science and establishing the basis for new technologies. An emblematic example is represented by Keggin-type heteropolycompounds with cesium and vanadium, which are promising catalysts to convert isobutane and 2MPDO to MAA. Renewable sources for the MMA or MAA route include acetone, isobutanol, ethanol, lactic, itaconic, and citric acids. End-of-life PMMA is expected to grow as a future source of MMA.

Received 1st June 2018

DOI: 10.1039/c8cs00117k

rsc.li/chem-soc-rev

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[b] Arkema, 420 Rue d'Etienne d'Orves, 92705 Colombes, France
[c] Department of Industrial Chemistry "Toso Montanari", University of Bologna, Viale Risorgimento 4, 41 036 Bologna, Italy
[d] Chemical Engineering Department, Sahand University of Technology, Sahand New Town, P.O. Box: 51335-1996, Tabriz, East Azerbaijan, Iran
† Electronic supplementary information (ESI) available. See DOI: 10.1039/c8cs00117k

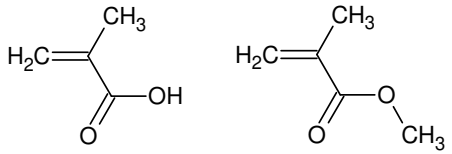
Mohammad Jaber Darabi Mahboub

Dr Mohammad Jaber Darabi Mahboub received his PhD in Chemical engineering in 2018 at Polytechnique Montreal, Canada under the supervision of Prof. Gregory Patience. He received his BSc and MSc in Chemical Engineering at Ferdowsi University of Mashhad (Iran). He has completed experimental work on the partial oxidation of 2-methyl-1,3-propandiol to methacrylic acid and is modelling the kinetics in collaboration with Arkema, France.

Jean-Luc Dubois

Dr Jean-Luc Dubois is Scientific Director at Arkema, dealing with Catalysis, Processes, Renewables and Recycling. Graduated from the HEI, he did a Voluntary Service Overseas in Saudi Arabia at the KFUPM/RI. He obtained his PhD from IFP on Catalysts for Oxidative Coupling of Methane. After a Post-Doctorate at NCLI (Tsukuba, Japan), he found a position in Elf-Antar-France, and stayed 2 years with Japan Energy in a collaborative research on hydrodesulphurization catalysts. He moved to Elf-Atochem (now in-part Arkema) in 1997, where he worked on oxidation catalysts, dehydration of glycerol, oxidative coupling of alcohols, cross metathesis, hydroformylation, and reactive castor seed crushing.

Process routes



CO_2 → BIOCON-CO_2 / PYROCO_2

Acetone → **Acetone Cyanhydrine**

Propylene → Isobutyraldehyde

Propane

Isobutane

Isobutyric acid

ARKEMA 2-Methyl -1,3 Propanediol

Methacrylic Acid → **Methacrylic Acid Methyl Ester**

Itaconic Acid

Methacrylonitrile

Isobutanol

Methacrolein

Propanaldehyde

Methyl Propionate

Propyne / Methyl Acetylene / Propadiene

Sugar → **Isobutene** → **Ter-butanol**

Ethanol

Ethylene

PMMA

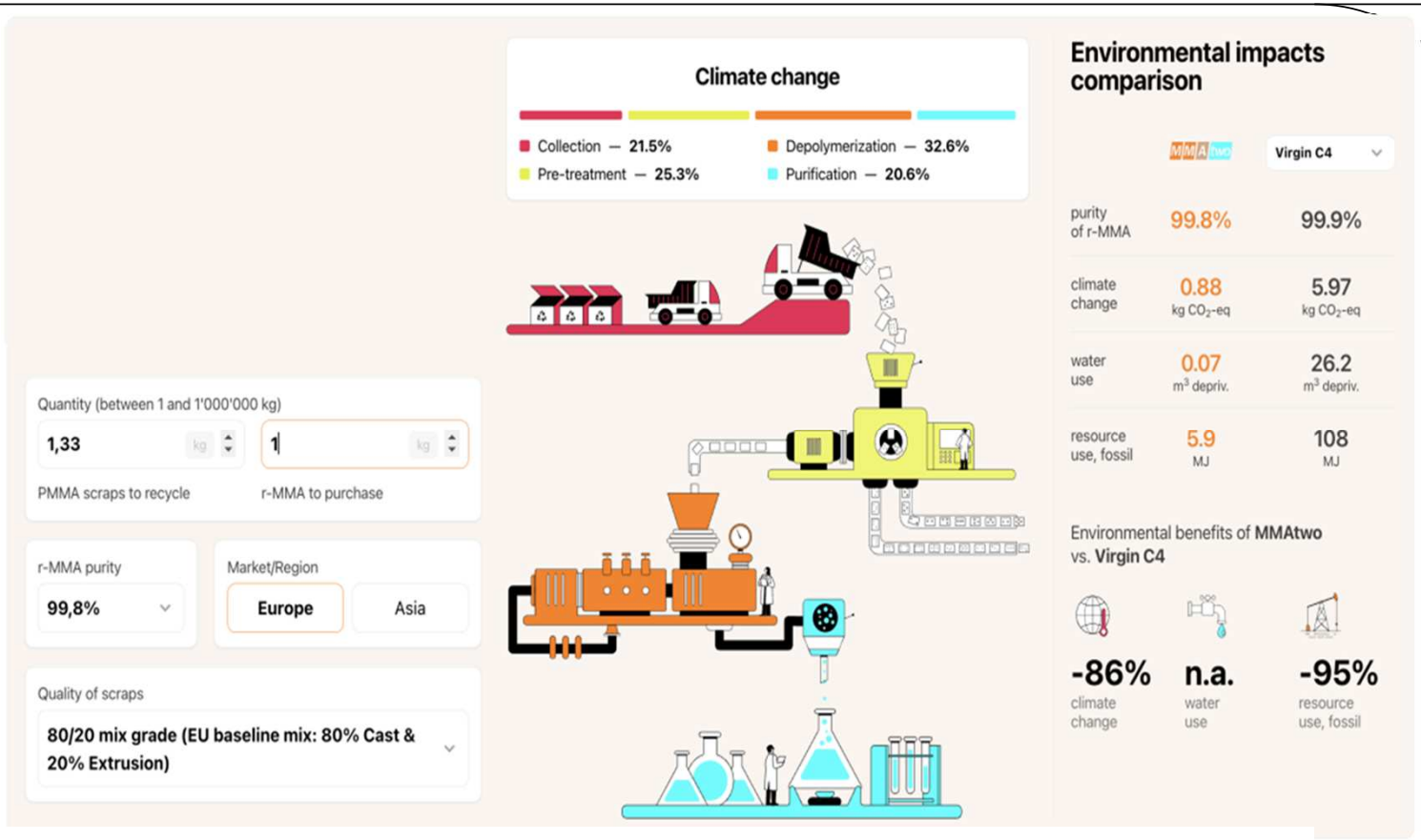
http://www.mmatwo-footprinter.eu/ (to be updated with final results soon)

Environmental Benefits Calculator BETA

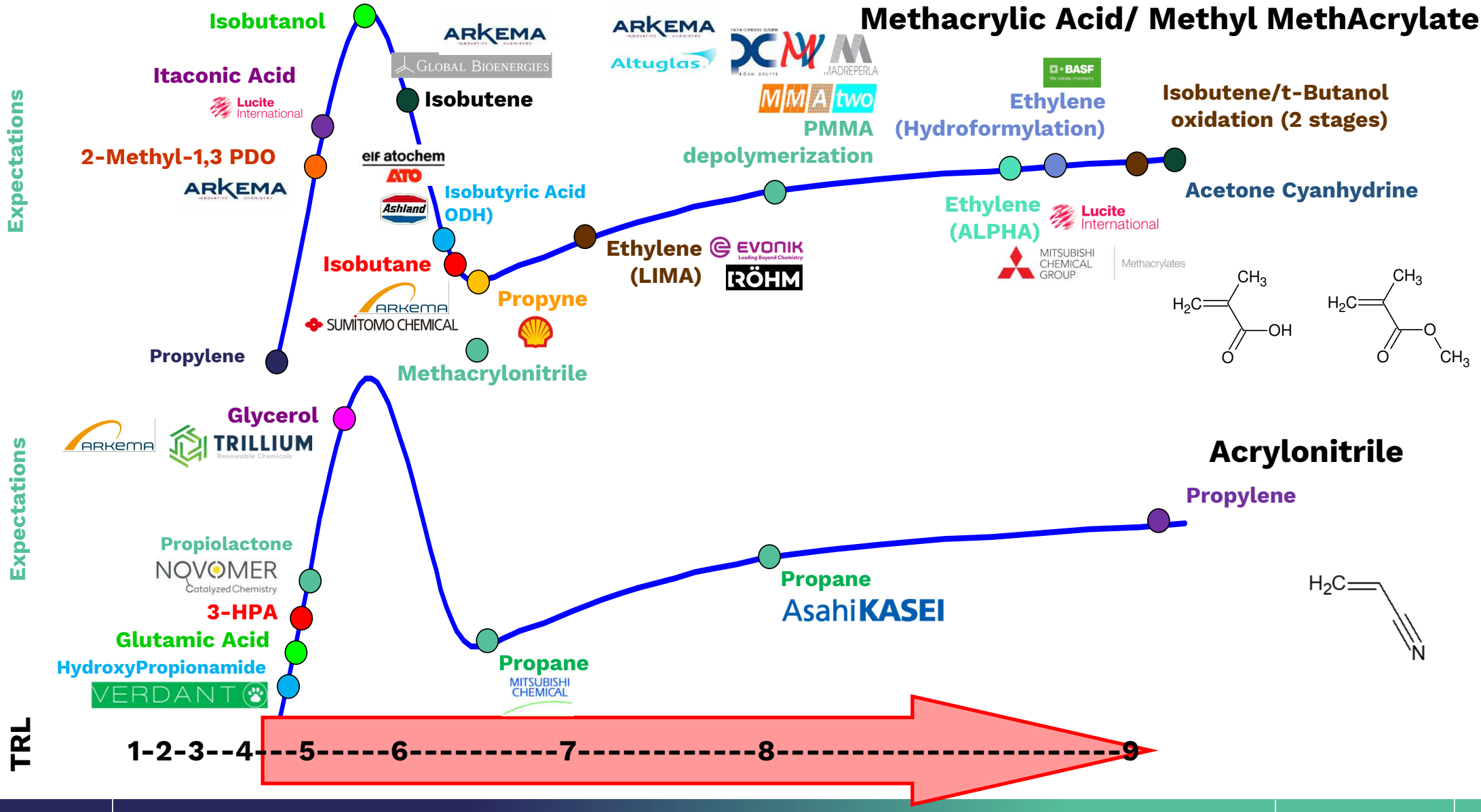
The final version will be available in September 2022.

The MMAtwo Project **aims at constructing a novel and fast growing PolyMethylMethAcrylate (PMMA) recycling value chain** based on the production of «Second Generation MethylMethAcrylate (MMA)» from post-consumer and post-industrial PMMA based products.

The technology is a cost effective and efficient recycling process with **reduced energy consumption and CO_2 emissions**, that aims to **reduce the utilization of primary fossil resources** in the process industry by **at least 30%.**

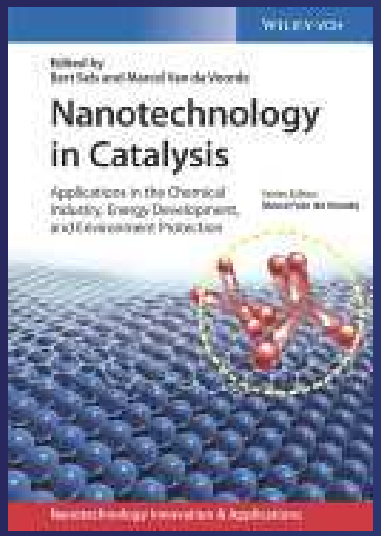


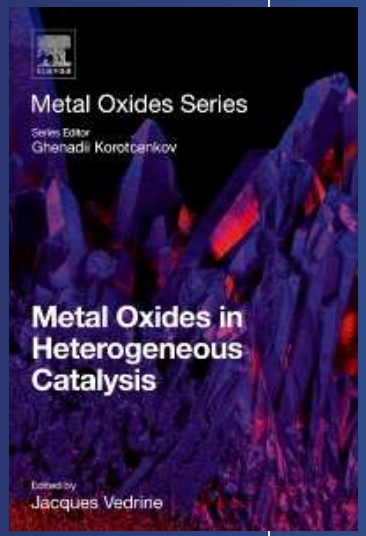
MMAtwo - This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 820687.

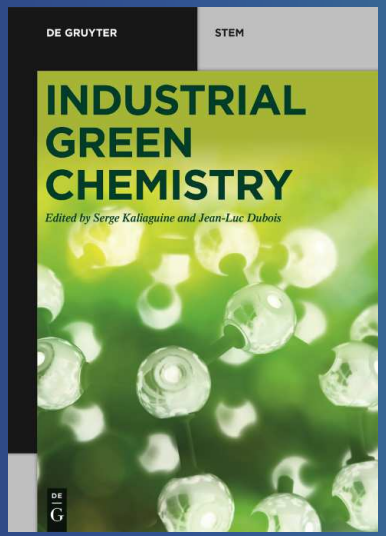

Methacrylic Acid/ Methyl MethAcrylate
Expectations
Isobutanol
Itaconic Acid
Lucite International
2-Methyl-1,3 PDO
ARKEMA
ARKEMA
GLOBAL BIOENERGIES
Isobutene
elf atochem
ATO
Ashland
Isobutyric Acid
ODH)
Isobutane
ARKEMA
SUMITOMO CHEMICAL
Propyne
Propylene
Methacrylonitrile
ARKEMA
Altuglas
DCM
MADREPERLA
MMA two
PMMA
depolymerization
BASF
Ethylene
(Hydroformylation)
Isobutene/t-Butanol
oxidation (2 stages)
Acetone Cyanhydrine
Ethylene
(ALPHA)
Lucite International
MITSUBISHI CHEMICAL GROUP
Methacrylates
Ethylene
(LIMA)
EVONIK
RÖHM
Expectations
Glycerol
ARKEMA
TRILLIUM
Renewable Chemicals
Acrylonitrile
Propylene
Propiolactone
NOVOMER
Catalyzed Chemistry
3-HPA
Glutamic Acid
HydroxyPropionamide
VERDANT
Propane
MITSUBISHI CHEMICAL
Propane
AsahiKASEI
TRL
1-2-3--4---5-----6----------7----------8----------9

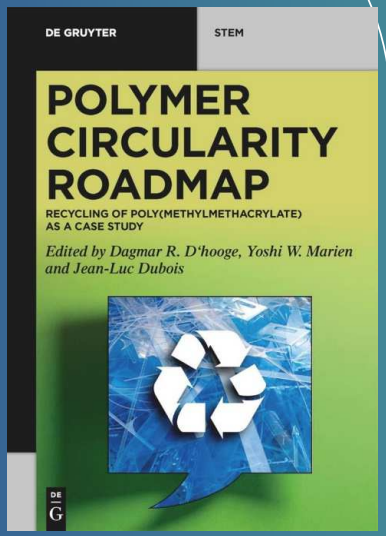
Merci pour votre attention

Suggestion de lectures









ARKEMA

Chain of Custody: Options for recycling / monomer regeneration

→ **Identity Preserved**	➢ Dedicated plant MMA two	Regenerated MMA 100 %
→ **Segregated**	➢ Single Plant, Batch-wise	Regenerated MMA 100 % / Virgin MMA
→ **Controlled Blending**	➢ Mixed stream, single product	Regenerated MMA 50%
→ **Mass Balance, Mixed streams**	➢ Allocation, Physical link	Regenerated MMA 75 % / Regenerated MMA 25%
→ **Book & Claim**	➢ Credits and Products follow different path	