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Polyolefins and their influence on single use technology for bioprocessing

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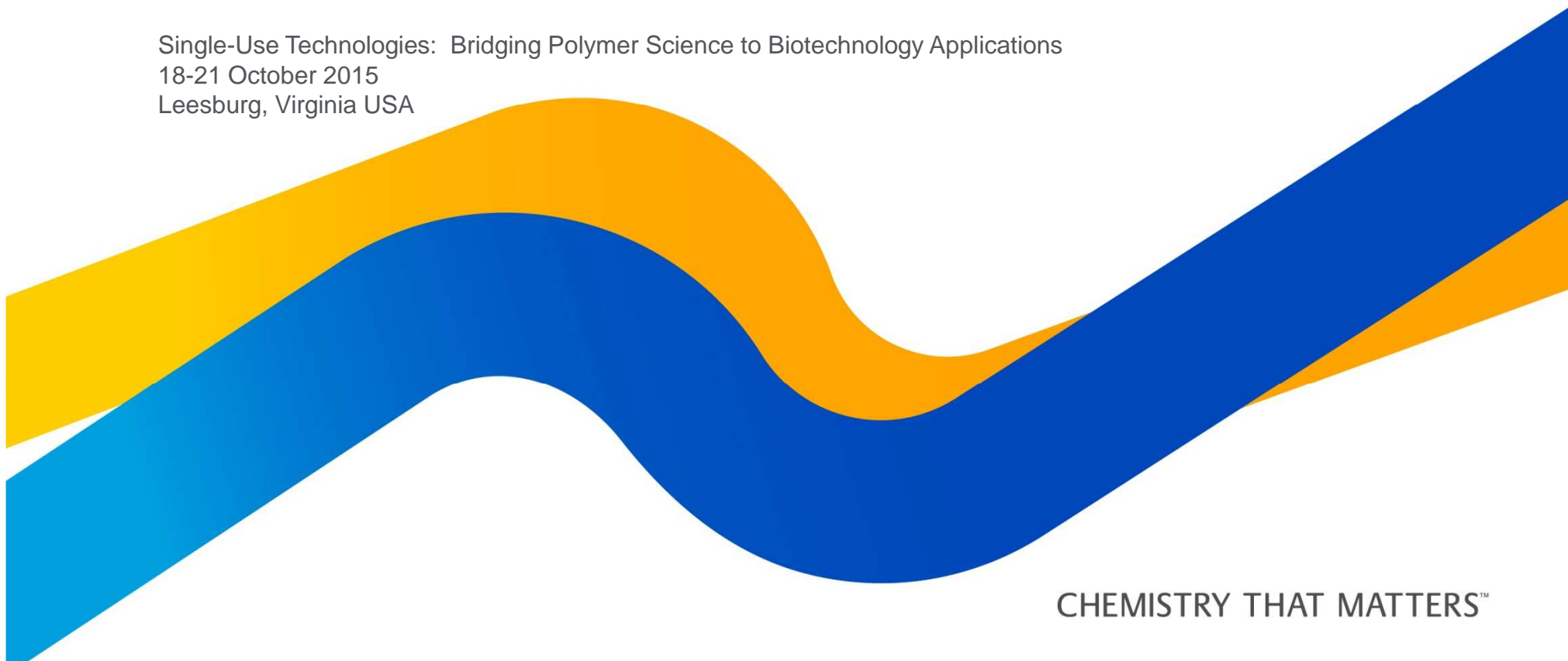
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POLYOLEFINS AND THEIR INFLUENCE ON SINGLE-USE TECHNOLOGY FOR BIOPROCESSING

Marnik Vaes & Amy Plancon

Single-Use Technologies: Bridging Polymer Science to Biotechnology Applications
18-21 October 2015
Leesburg, Virginia USA



CHEMISTRY THAT MATTERS™

POLYOLEFINS AND THEIR INFLUENCE ON SINGLE-USE
TECHNOLOGY FOR BIOPROCESSING

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CONTENT

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CHEMISTRY THAT MATTERS™ FOR SINGLE USE TECHNOLOGY

POLYOLEFINS AND THEIR INFLUENCE ON SINGLE-USE
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INTRODUCTION: CHEMISTRY THAT MATTERS™

SABIC IN NUMBERS

1976, our beginning

39 years of growth

3rd largest global diversified chemical company*

116th largest public company in the world*

91 B\$ total assets

50 B\$ annual revenue

6.2 B\$ net income

40,000 employees

50 countries

5 Strategic Business Units

64 world-class plants worldwide

5 key geographies with innovation hubs

150 new products each year

10,640 global patent filings

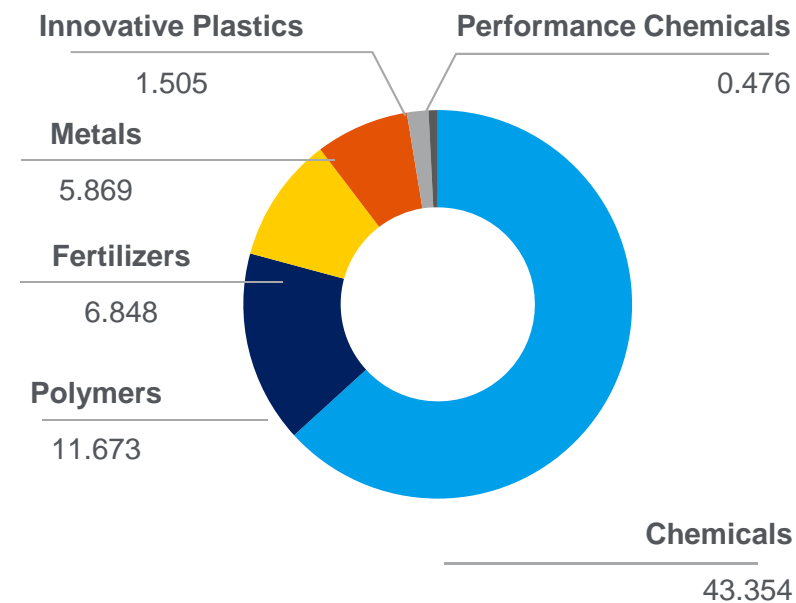
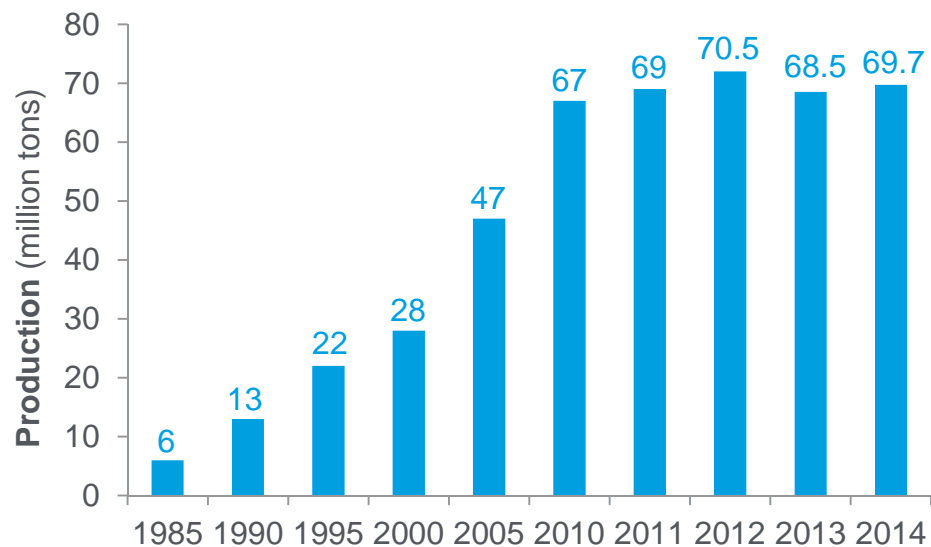
* Forbes 2015



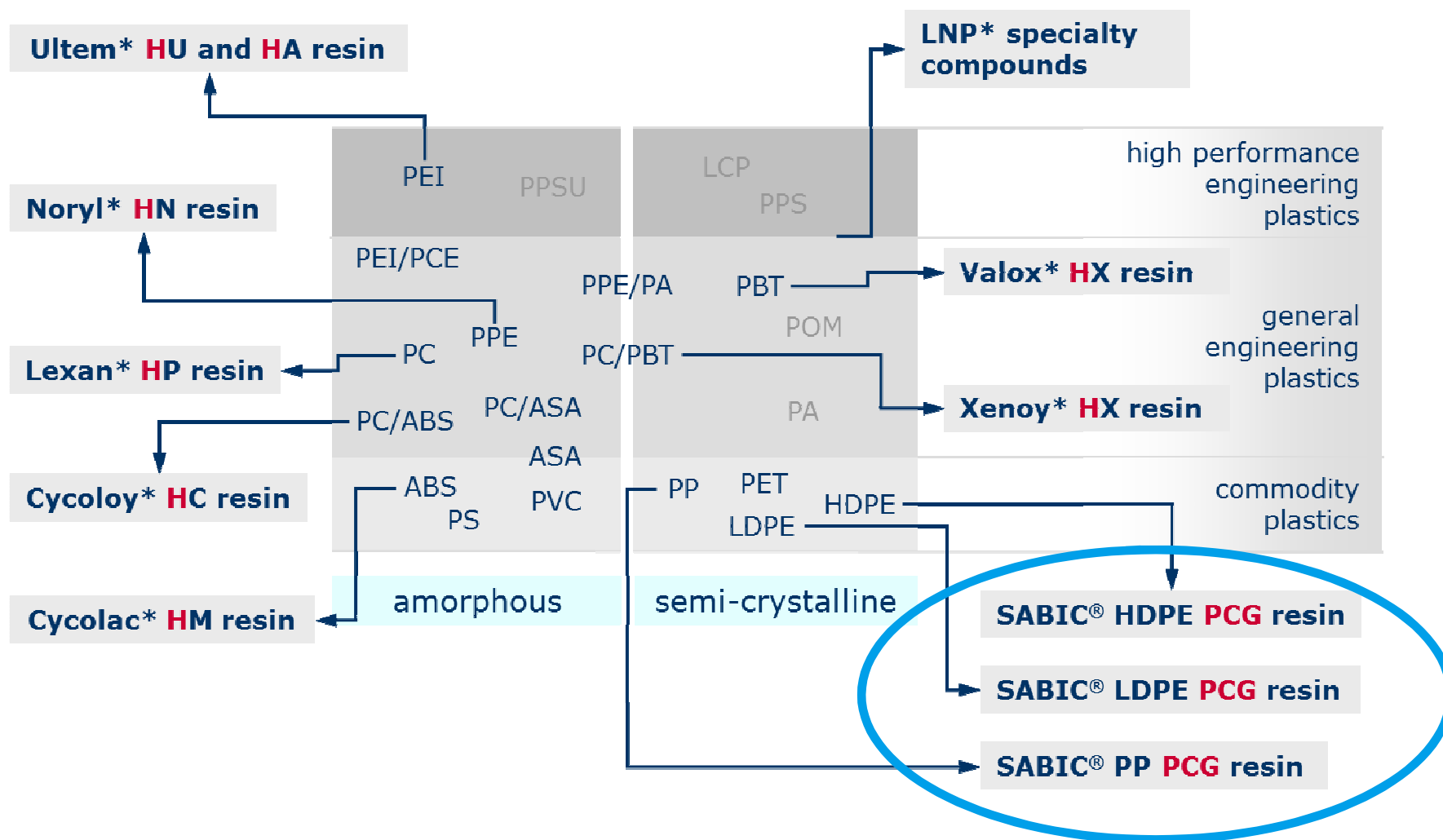
PRODUCTION HAS MULTIPLIED BY 5 IN 20 YEARS

A high rate of growth...

...reaching 69.7M metric tons in 2014



COMPREHENSIVE HEALTHCARE SOLUTIONS



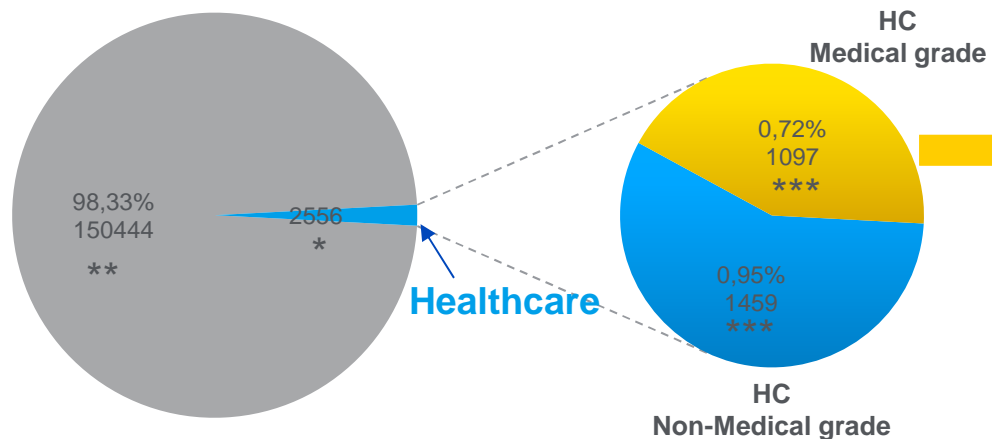
WORKING TOGETHER: CHEMISTRY THAT MATTERS™



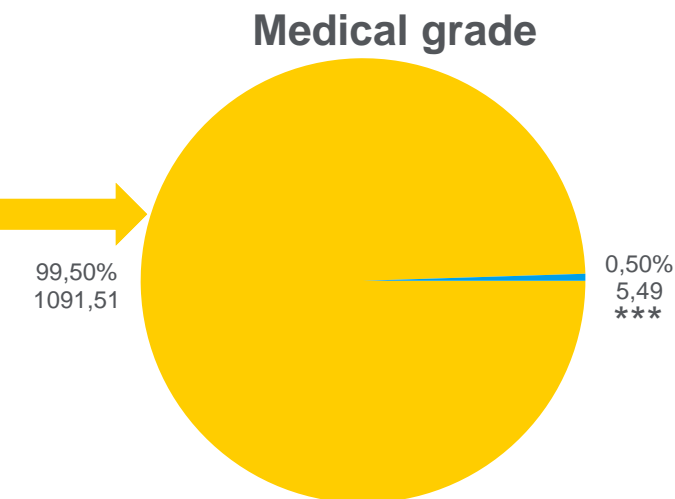
Help our customers grow so as to help preserve and improve human life around the world

GLOBAL POLYOLEFIN MARKET

Global Healthcare Polyolefin Demand, KT



Polyolefins in SUS (KT, estimated)

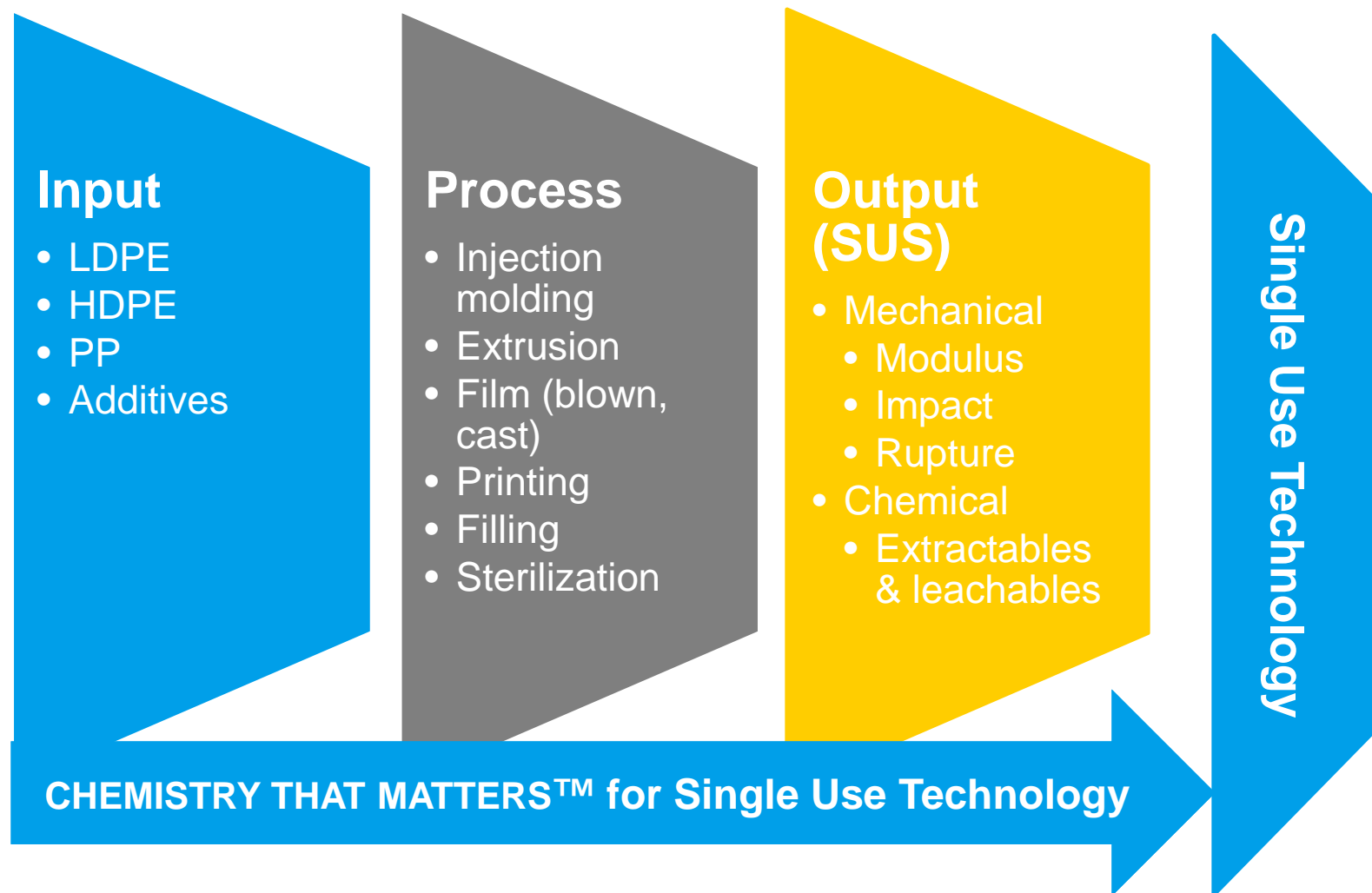


■ Global Non-HC PO
 ■ Global HC Non-medical
 ■ Global HC Medical
 ■ Global HC EP/USP
 ■ SUS

➤ **Medical grade = EP and USP compliant materials**

* Source: BCC Research 2013
 ** SABIC Market Intelligence
 *** Estimated

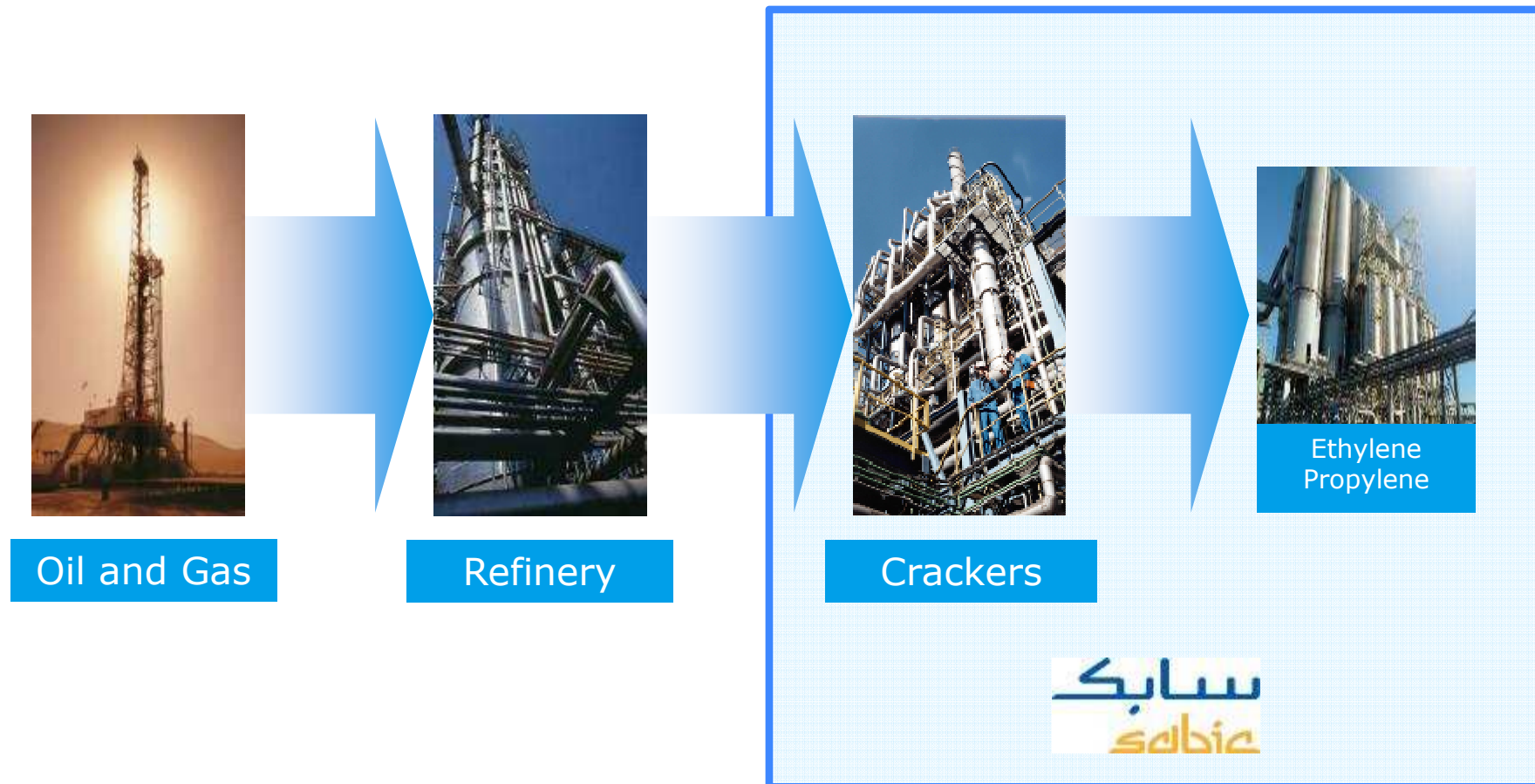
POLYOLEFINS & INFLUENCE ON SUT



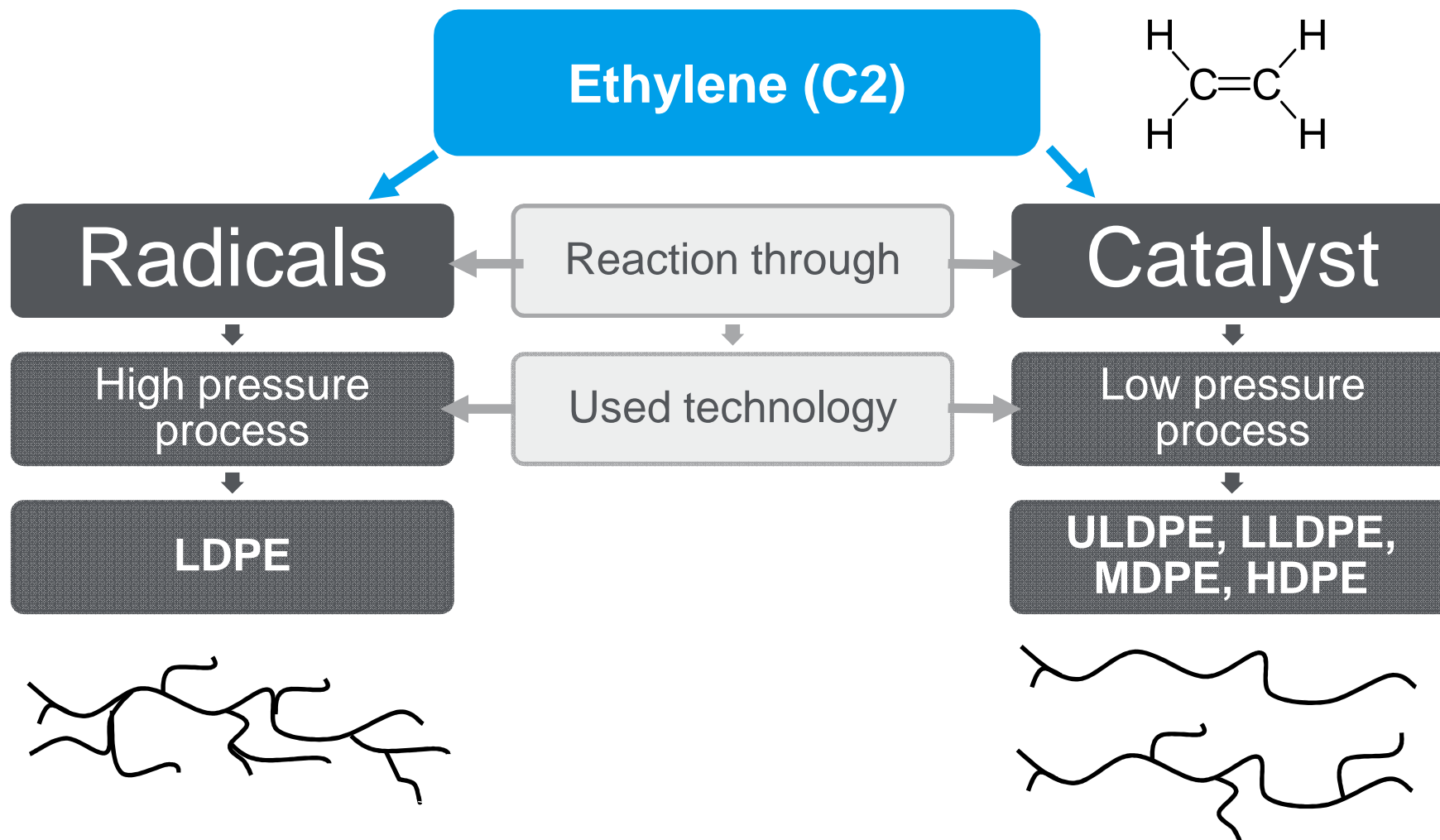
POLYOLEFINS AND THEIR INFLUENCE ON SINGLE-USE
TECHNOLOGY FOR BIOPROCESSING

POLYOLEFINS: POLYETHYLENE & POLYPROPYLENE

FROM OIL TO OLEFINS



POLYMERIZATION PROCESS

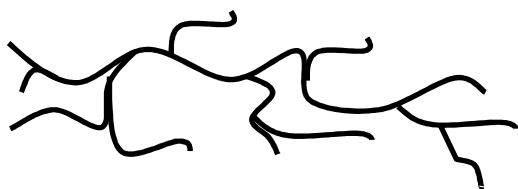


POLYETHYLENE (C2) STRUCTURE

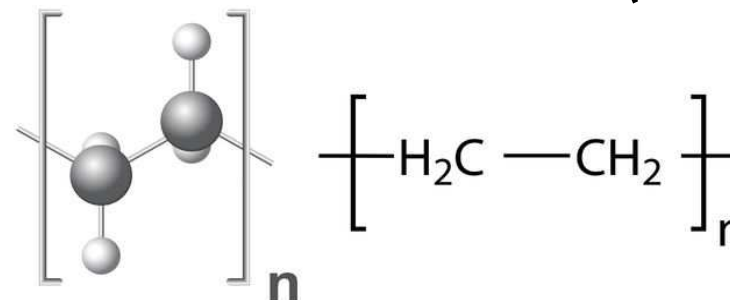
LDPE: Branched

HDPE: Linear

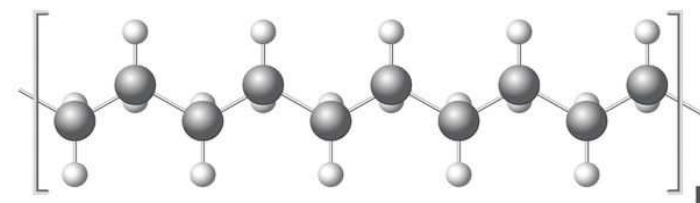
LLDPE: Linear



Chemical structure



Molecular structure

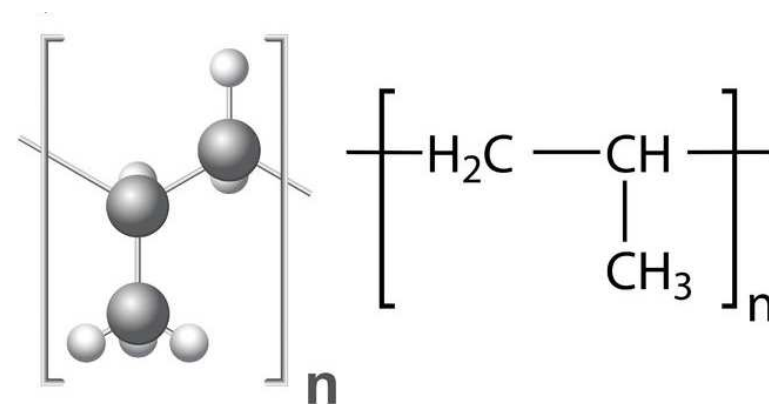


LLDPE contains side chains by co-polymerization of ethylene with monomer (e.g. butane, hexane, etc)

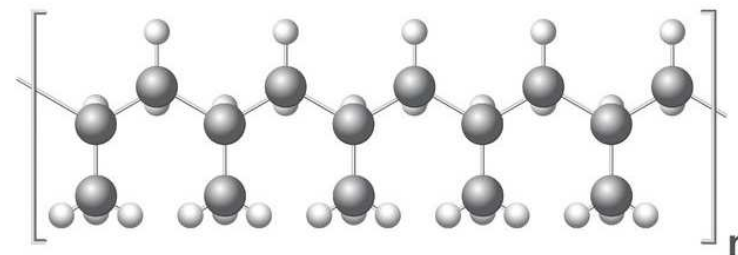
POLYPROPYLENE (C3) STRUCTURE



Chemical structure



Molecular structure



POLYOLEFINS AND THEIR INFLUENCE ON SINGLE-USE
TECHNOLOGY FOR BIOPROCESSING

KEY PROPERTIES:

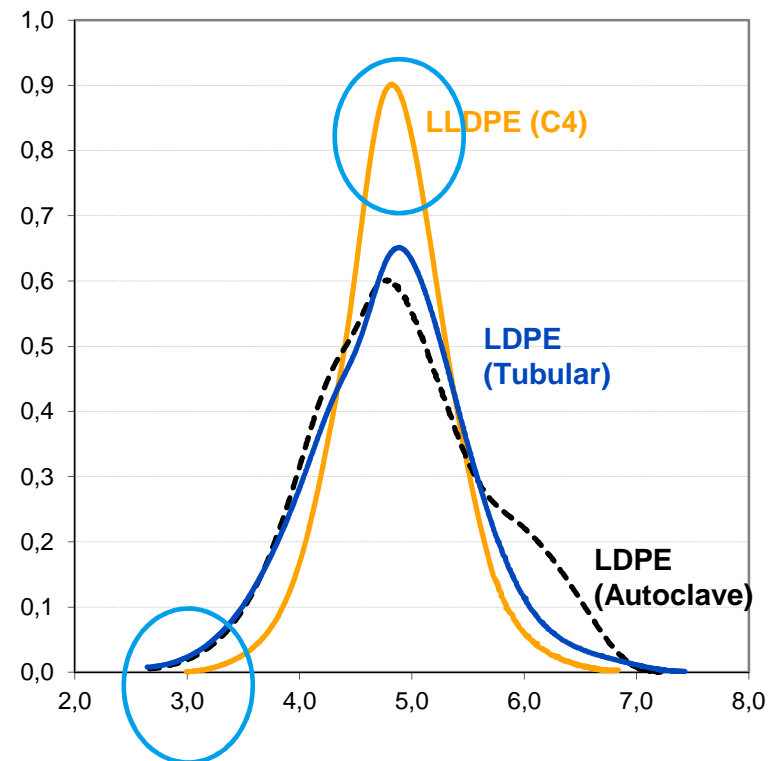
PHYSICAL

MECHANICAL

CHEMICAL & ADDITIVES

PHYSICAL PROPERTIES: MOLECULAR WEIGHT DISTRIBUTION (MWD)

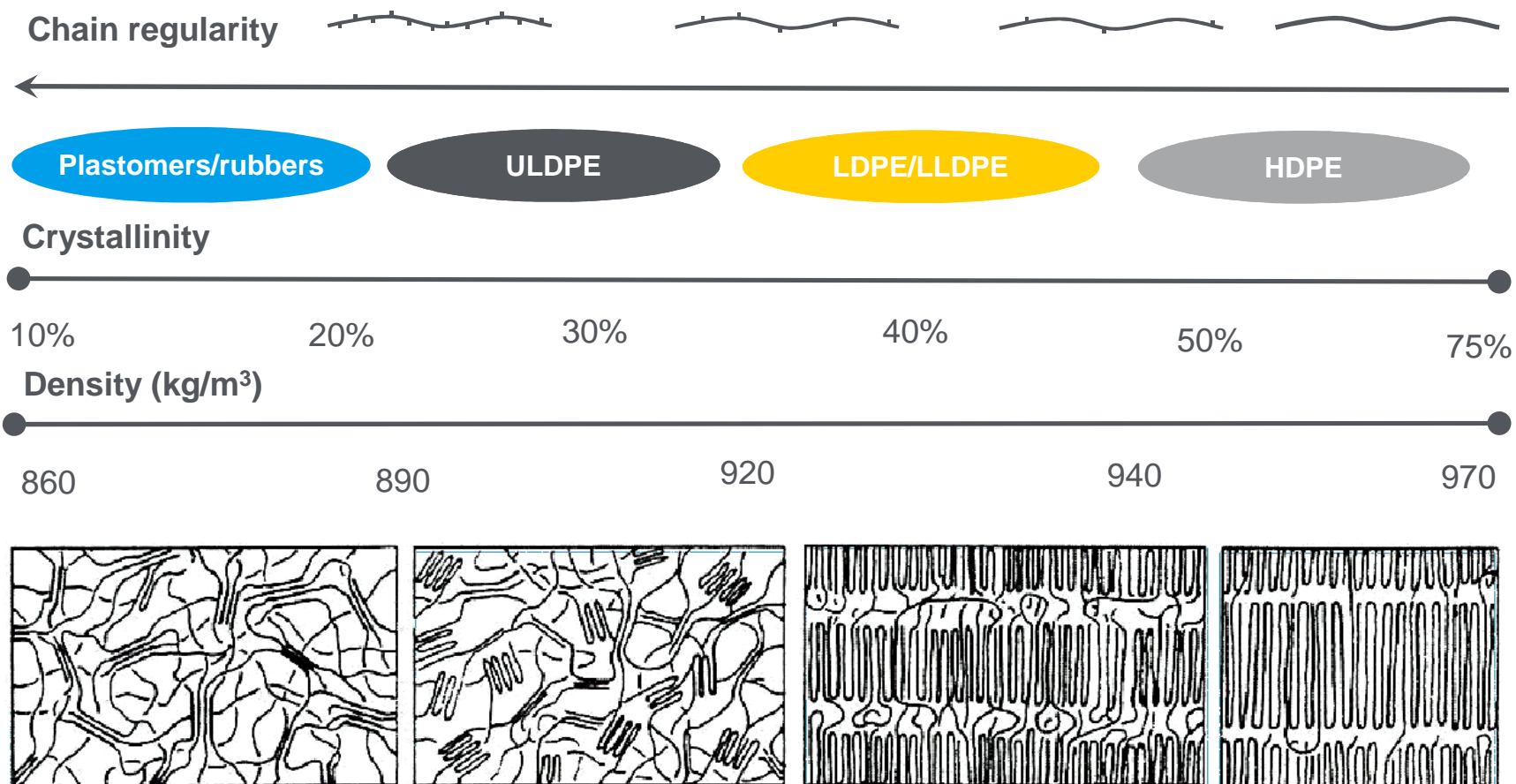
- Polymers have a distribution of chain lengths
- Production technology allows some tailoring of MWD:
 - Narrow distribution for film grades
 - Broader distribution for injection molding grades
- Melt Flow Index (MFI) is inversely proportional to MW



Chain lengths range from very short... ...to very long

PHYSICAL PROPERTIES: DENSITY & CRYSTALLINITY

➤ **LDPE has Long Chain Branches and Short Chain Branches**



MECHANICAL PROPERTIES

Tensile Modulus

- Resistance of materials to tensile force.

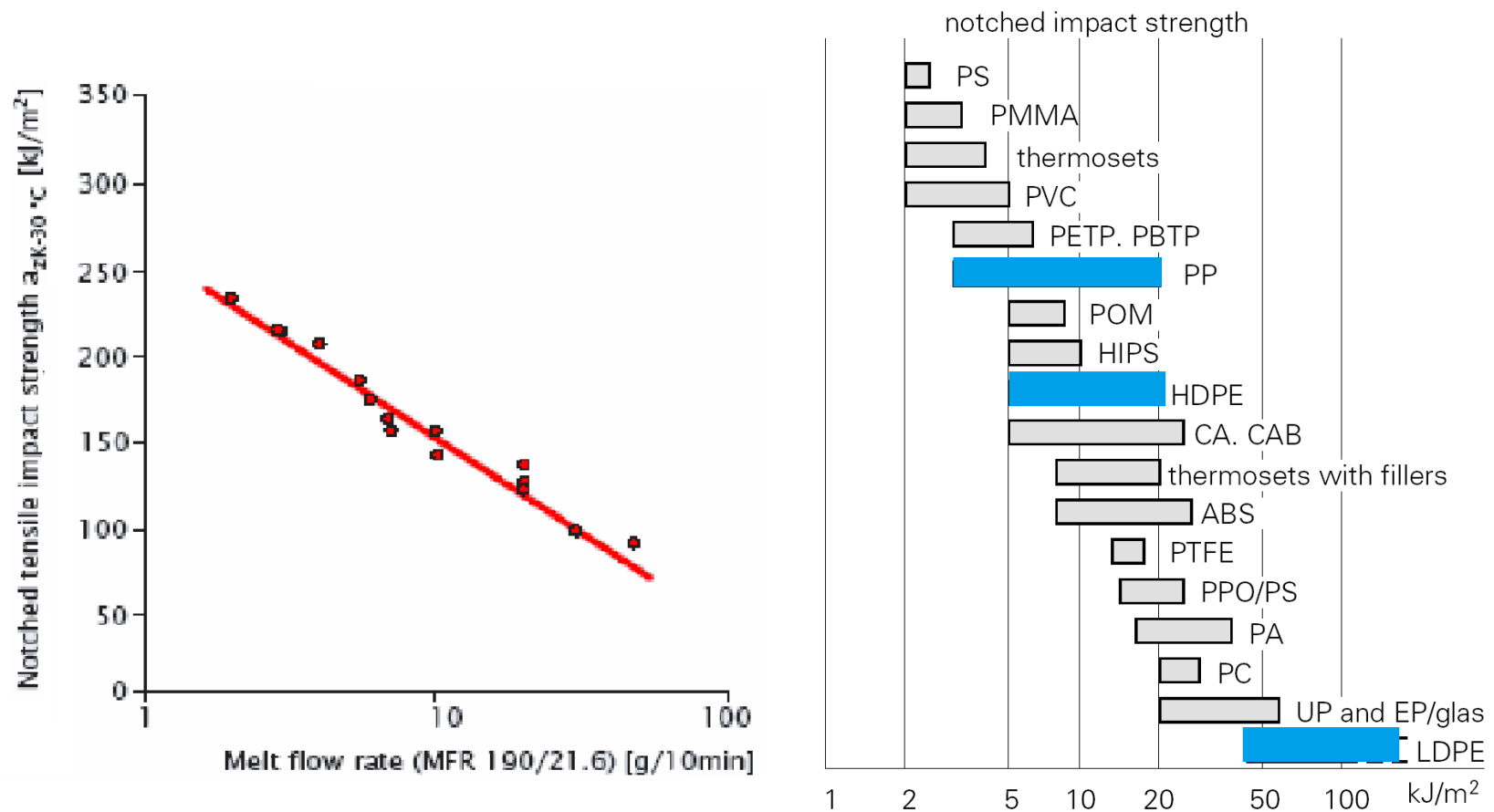
Flex Modulus

- Resistance of materials to flexural force

Izod Impact

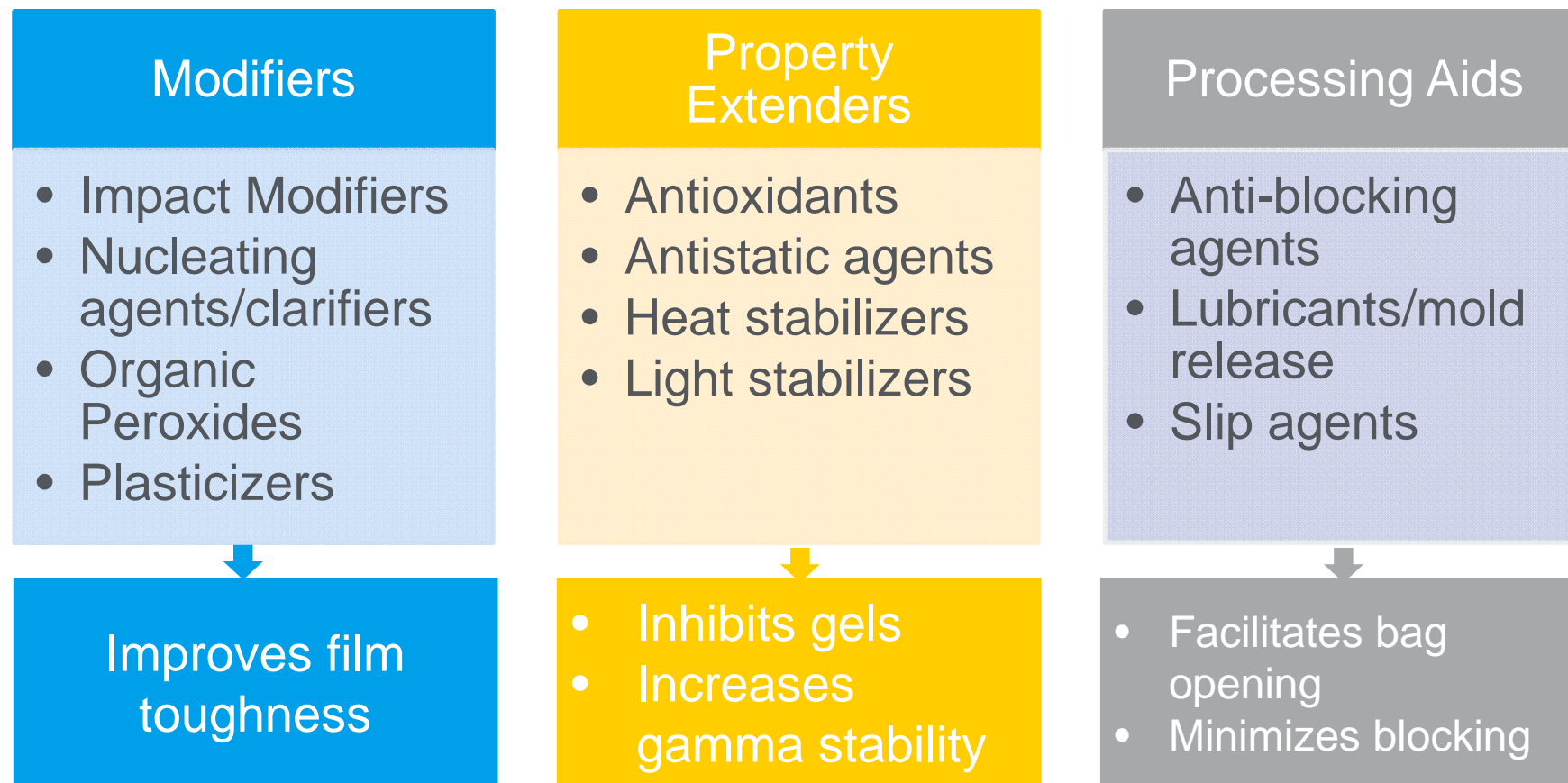
- Resistance of materials to impact at several temperatures

MECHANICAL PROPERTIES: IMPACT STRENGTH



Impact strength is influenced by melt index and density

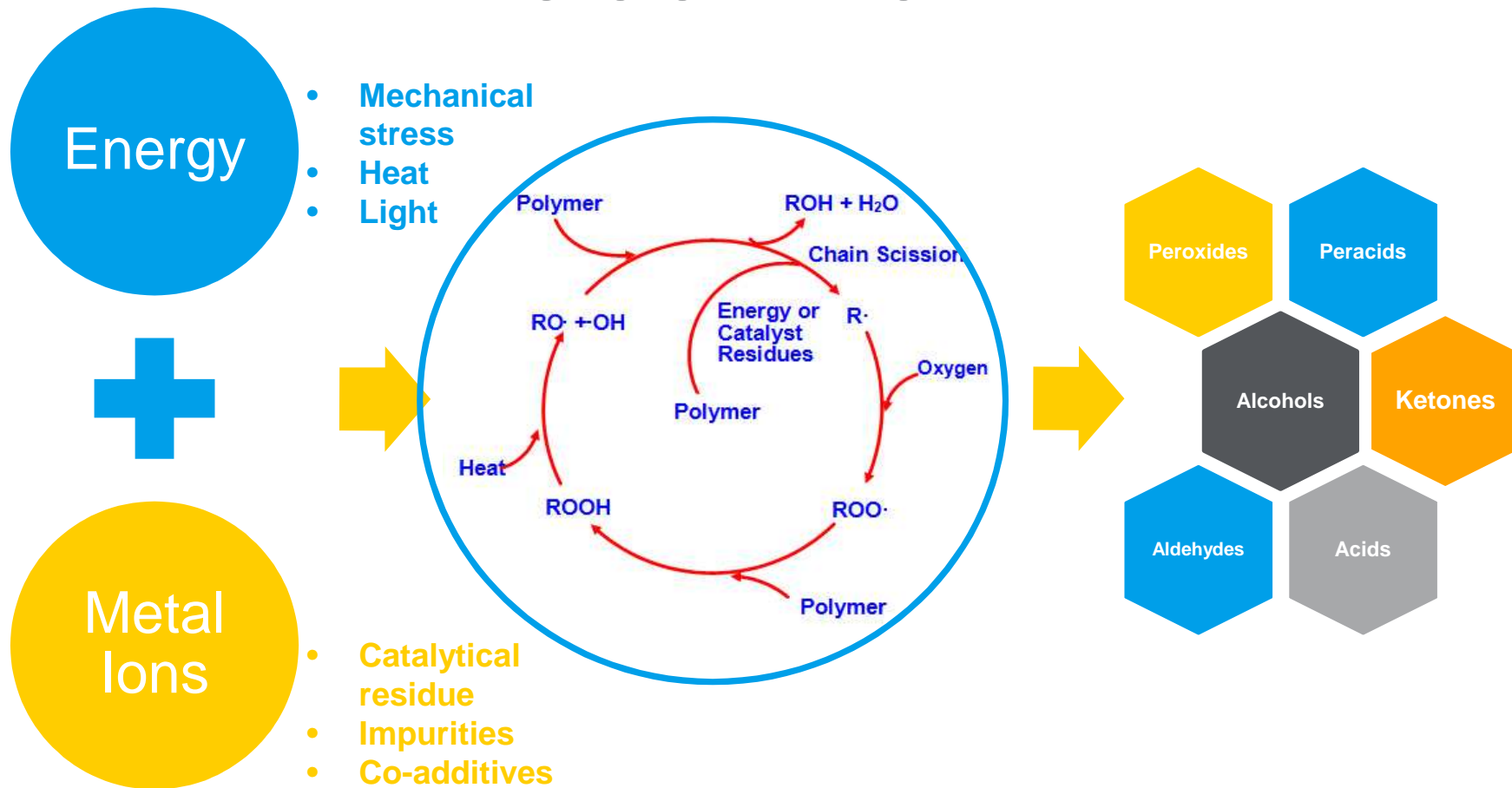
CHEMICAL PROPERTIES: TYPES OF ADDITIVES



➤ **Additives are used to improve processing of polymers and to enhance their properties**

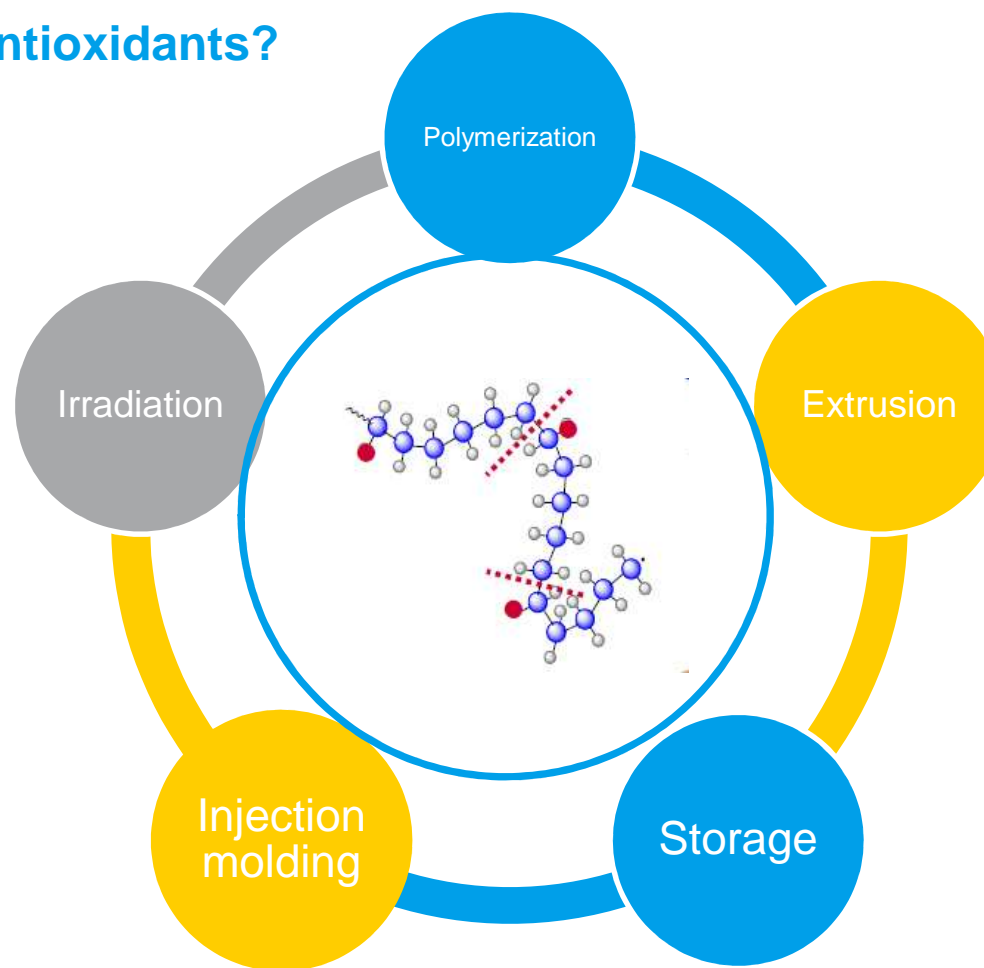
CHEMICAL PROPERTIES: OXIDATION & POLYMER DEGRADATION

AUTO-OXIDATION



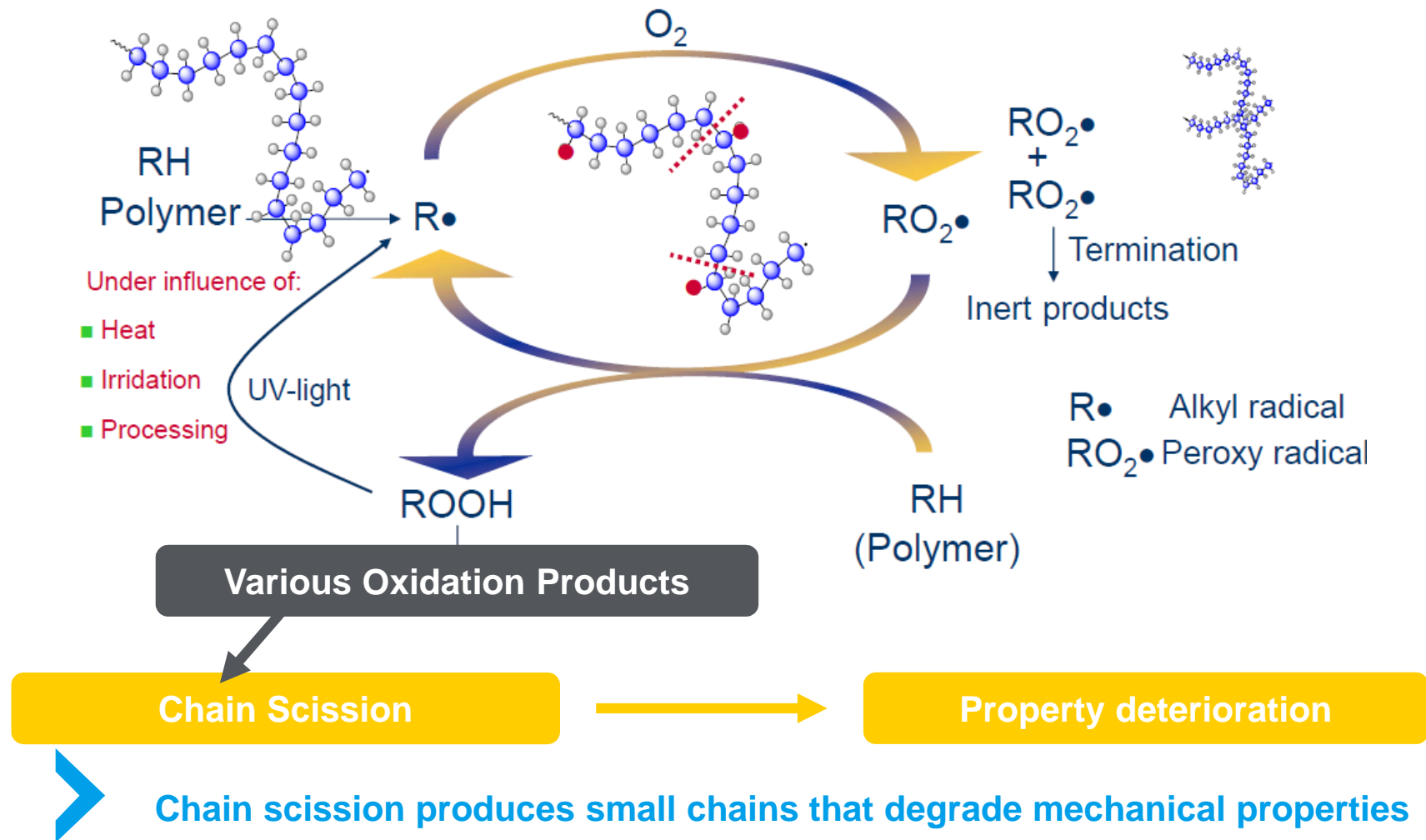
CHEMICAL PROPERTIES: OXIDATION & ANTIOXIDANTS

➤ Why do we use antioxidants?



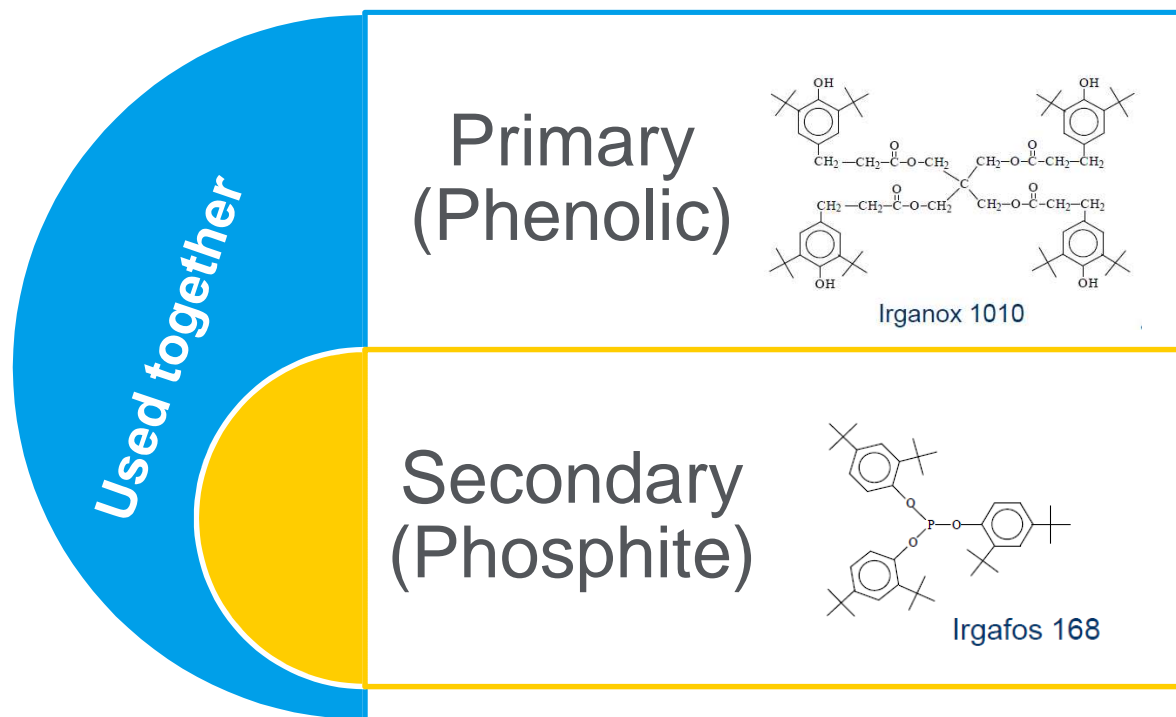
➤ Auto-oxidation
ALWAYS takes
place

CHEMICAL PROPERTIES: DEGRADATION CHEMISTRY



CHEMICAL PROPERTIES: ANTIOXIDANTS & DEGRADATION

➤ Antioxidants are used in most polymer resins to prevent oxidative degradation



➤ Oxidative degradation can lead to gels and black specs in PE film

CHEMICAL PROPERTIES: EXTRACTABLES & LEACHABLES

Solvent	BP	GC-MS	UPLC-HRMS (+ & - APCI)	Headspace
Ethanol	78 °C	➤	➤	
DCM	40 °C	➤	➤	
Hexane	69 °C	➤	➤	
Water pH 2, 7, 9	100 °C	➤	➤	
Neat	"150 °C"			➤

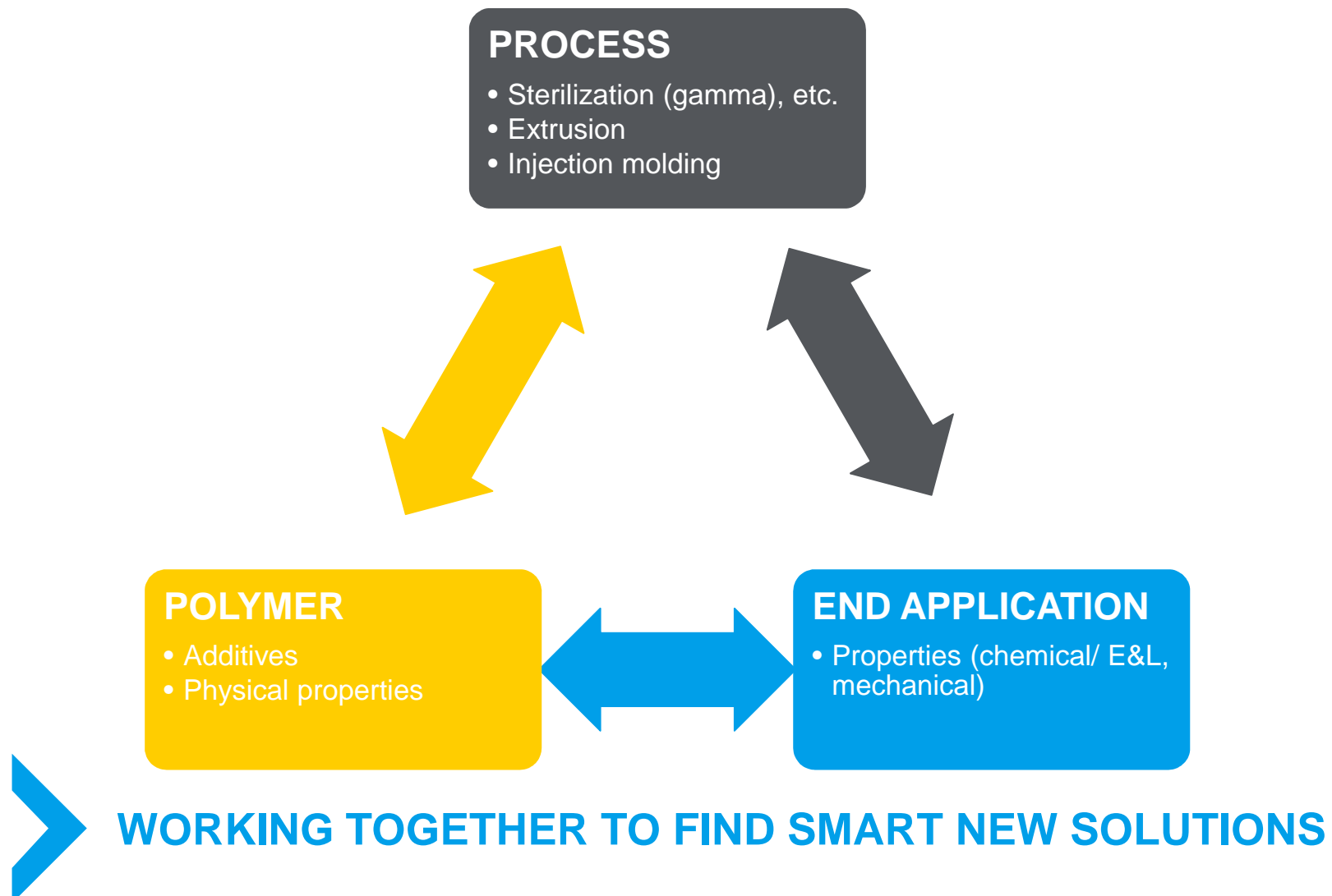
➤ Degradation products can impact E&L

➤ CHEMISTRY THAT MATTERS™: ensure "what comes out" will work in SUT

POLYOLEFINS AND THEIR INFLUENCE ON SINGLE-USE
TECHNOLOGY FOR BIOPROCESSING

SUMMARY:
**CHEMISTRY THAT
MATTERS™ FOR SINGLE
USE TECHNOLOGY**

CHEMISTRY THAT MATTERS™ FOR SUT



CHEMISTRY THAT MATTERS™

THANK YOU



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