

PLACE 2016

EXPLORING
NEW FRONTIERS

April 11-13 2016
FORT WORTH, TEXAS

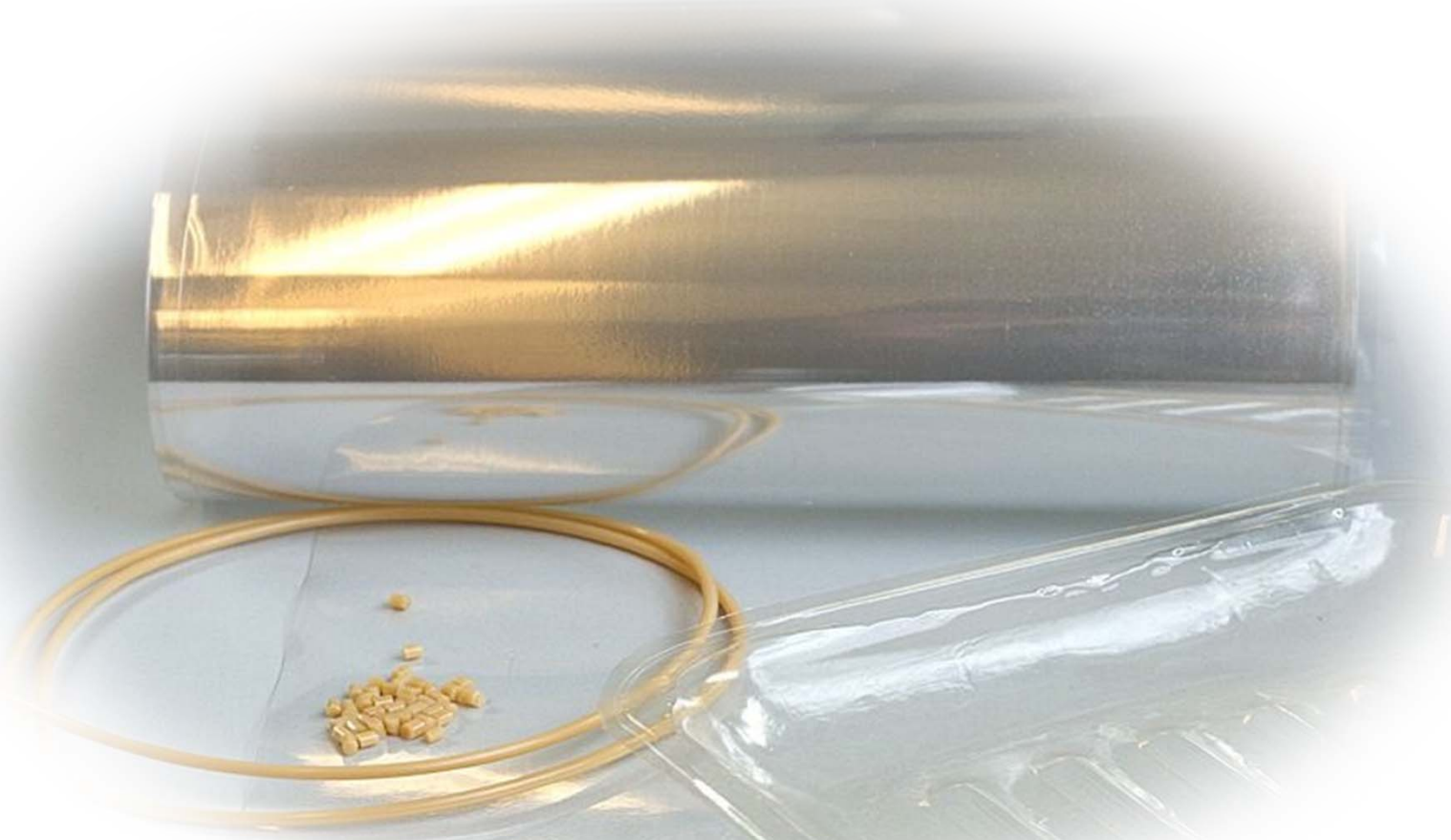
Development of PGA barrier polymer at VTT

Presented by:

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PGA polymer development

From monomer through polymer into multilayer films

Our place as a performer of R&D work

BASIC RESEARCH

UNIVERSITIES

APPLIED RESEARCH

VTT

DEVELOPMENT

INDUSTRY

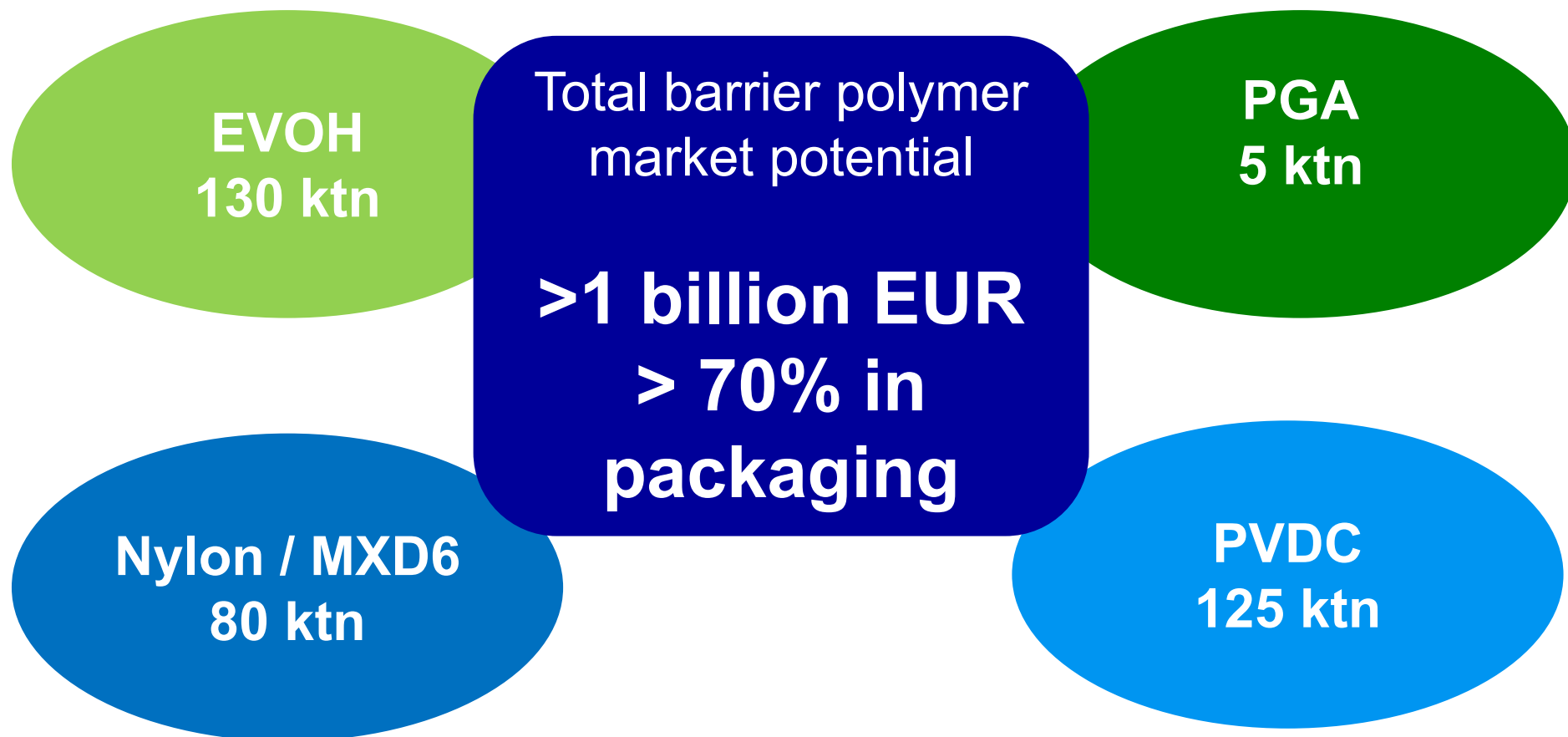


‘PGA from a new process by VTT’ – Superior oxygen barrier and mechanical performance polymer

- Target market is barrier films for food and beverage packaging.
- Global packaging barrier polymer market > 1 billion EUR.
- Targeting market entry with PGA production in 2018, growing the capacity to 8 000 tons by 2021.
- Patented polymerization technology enabling affordable availability of PGA polymer.



Barrier polymer market

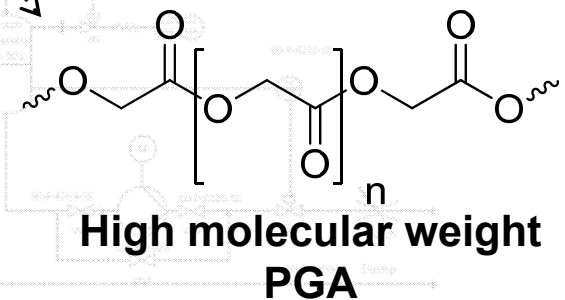
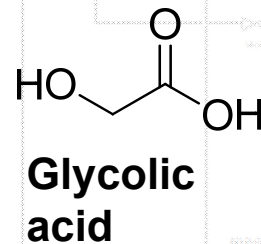
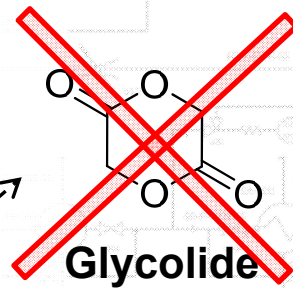


The diagram shows a complex process flow for PGA synthesis. Key components include:

- Glycolic acid** input at the top left.
- Oligomer synthesis reactor** (DC-20S A/B/C/D) in the center.
- Extruder** indicated by a blue arrow pointing from the reactor.
- Chemical structures:**
 - Glycolic acid:** OC(=O)CO
 - Glycolide:** O=C1OC(=O)CO1 (crossed out with a red X)
 - High molecular weight PGA:** [*]OC(=O)COOC(=O)COOC(=O)CO[*]
- Annotations:**
 - A blue box states: **~75% of unit operations unnecessary**.
 - A red box indicates a **-30%** reduction.
 - Text on the right: **Patent application WO2014/18110**.

~75% of unit operations unnecessary

Patent application WO2014/181040



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Performance advantage

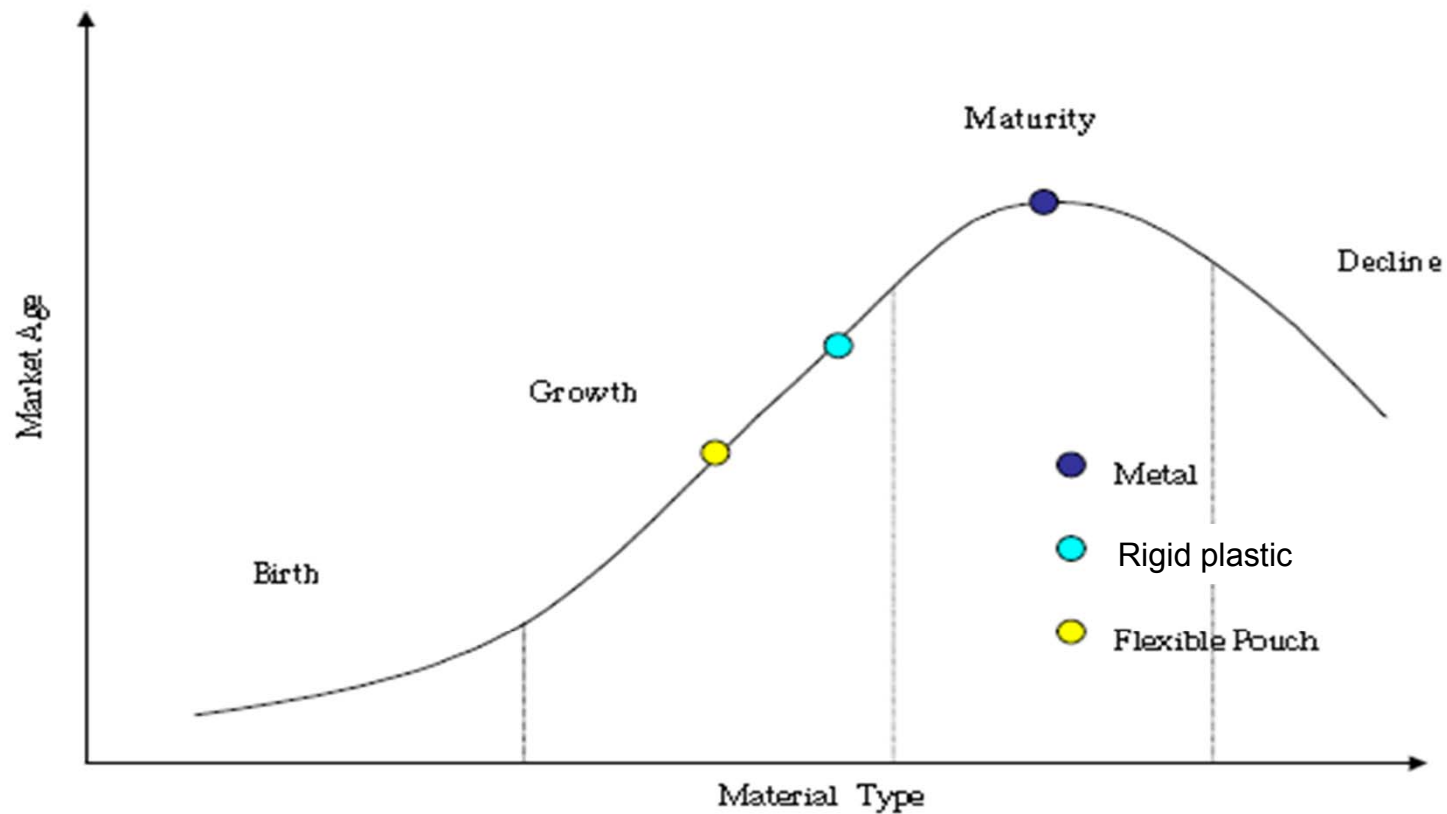
Item	new PGA	Market PGA	MXD6	EVOH 44%
Biodegradable	yes	yes	no	no
T _m [°C]	207	220	218	168
OTR	0.4	0.1	1.0	0.5
Tensile strength [MPa]	79	117	99	61
Elongation [%]	>100	13	3.5	280
Tensile Modulus [GPa]	7.3	7.0	4.7	2.1
Price [€/kg]	“x”	“5.5x”	“1.7x”	“x”

→ Price / Performance advantage

PGA for shelf stable retort packs

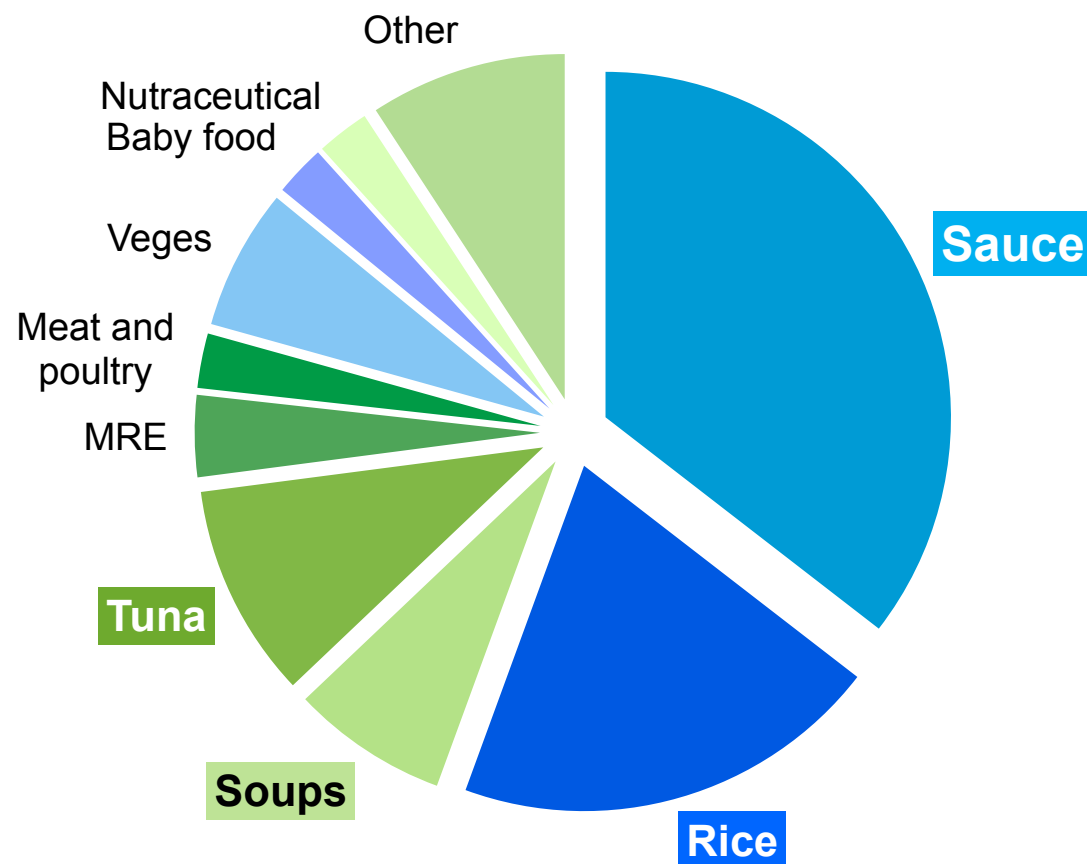
- Retort is the commercial method to sterilize the food (in 121 - 130 C, 10 - 40 min) inside a sealed barrier package.
- Typical materials for retort packaging are flexible and rigid plastic, and metal.
- Typically results in 12 - 24 month shelf life without refrigeration.
- Flexible plastic is the fastest growing segment in retort.

Flexible retort pouch

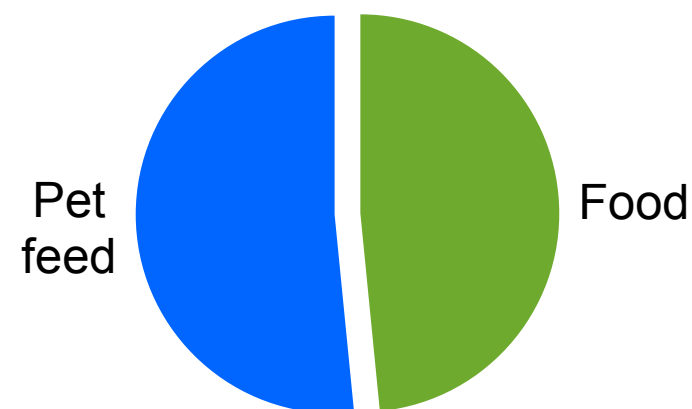


Source: Frost & Sullivan

Global retort pouch market

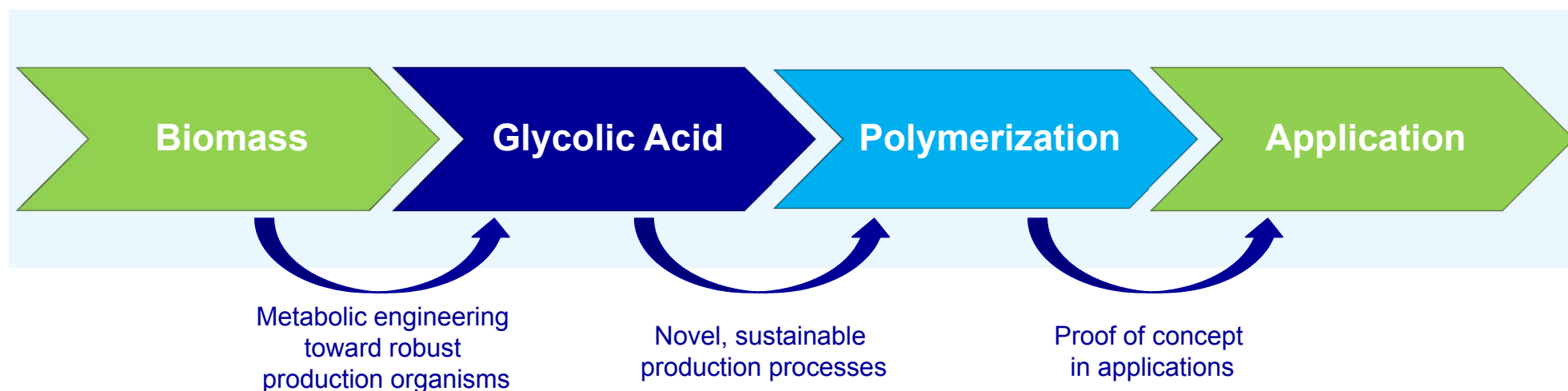


- Global volume 20 billion pouches, reaching \$1 billion
- CAGR >7%
- European trend



Allied Development, Retort Pouches 2011 - 2015

Bio-based glycolic acid value chain



■ Key benefits:

- Bio-based alternative routes
- Biodegradable polymer
- High performing barrier polymer
- Reduced consumption of other packaging components

‘new PGA’ summary

- 1. PGA performance benefits in packaging applications are already largely known**
- 2. Restricted availability**
- 3. Resin kg price for packaging barrier market**
- 4. VTT’s future process enabling access to the packaging market**

New PGA pilot manufacturing

- Produced in scalable batches (hundreds of kilos)
- High Molecular Weight ($M_{w.GPC} \sim 250,000$ g/mol)
- Applied for multilayer films
- Tested for applications



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Thank you

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