

# Biodegradable Polymer from Biomass

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# Product

## Biodegradable Polymer from a Biofuel Waste

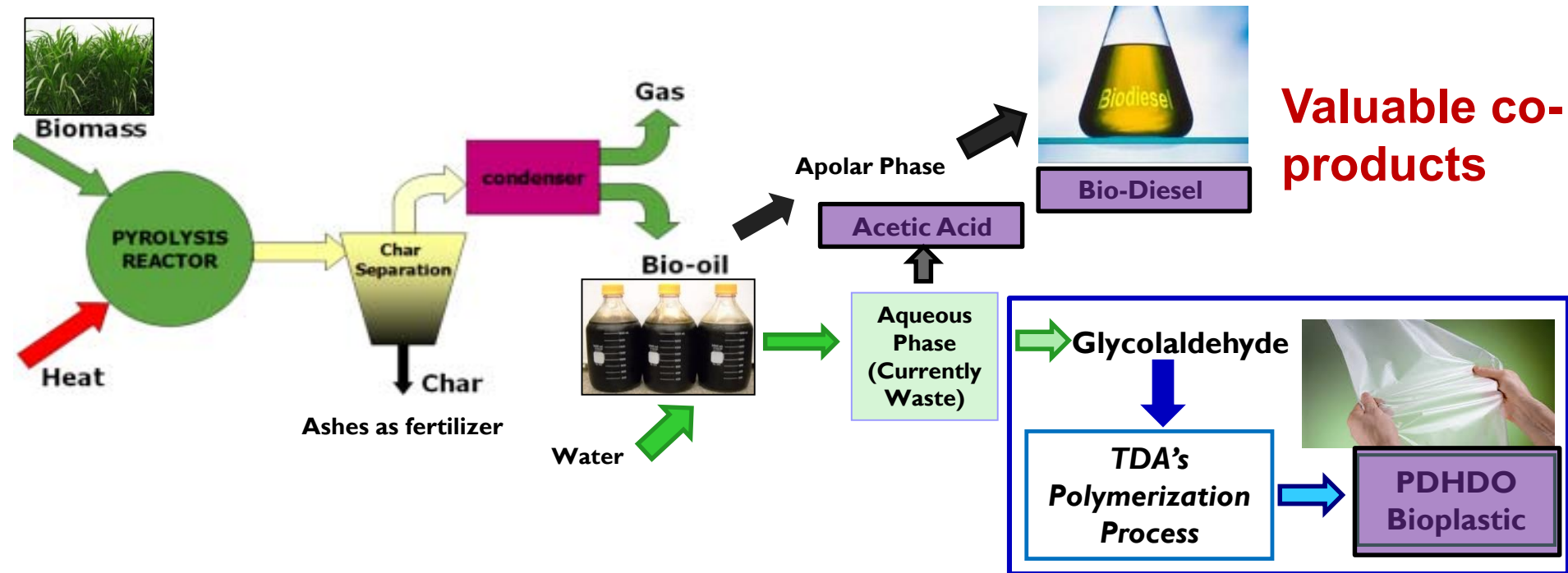
- TDA has a new invention - **PDHDO**
- **Poly(2,5-dihydroxy-1,4-dioxane)**
- New polymer from renewable, non-food source plant feedstock (lignocellulose)
  - *Compostable*
    - *Reduces landfill volume*
    - *Degrades rapidly*
  - LDPE Replacement
    - *Films (wrappers, plastic bags)*
    - *Coatings*
    - *Pellets, fibers*
    - *Fibers*

Patent issued for composition of matter and process

**US 9040635 – valid until 2034**

# Invention

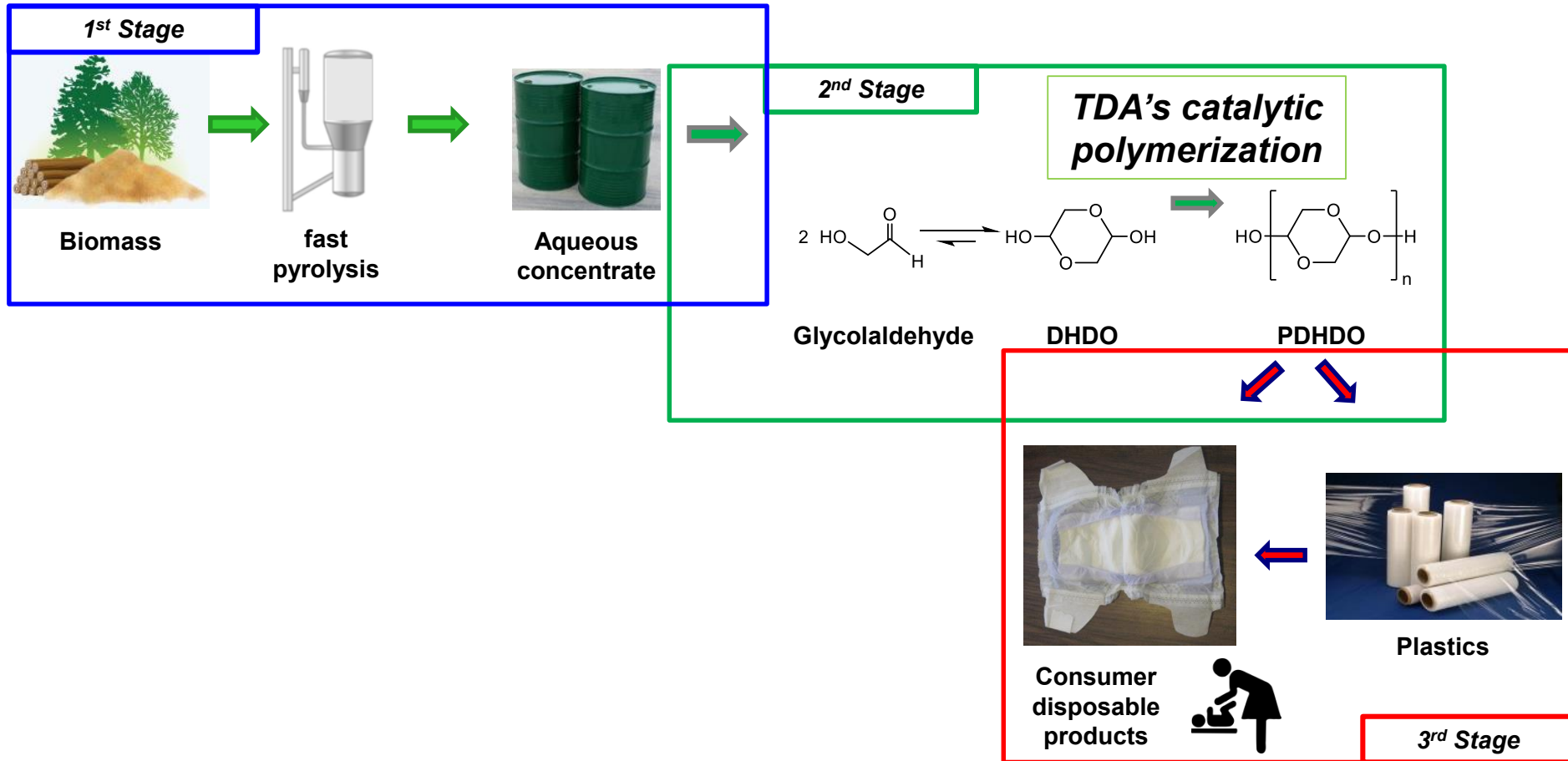
## Disruptive Technology



# How Our Product is Made

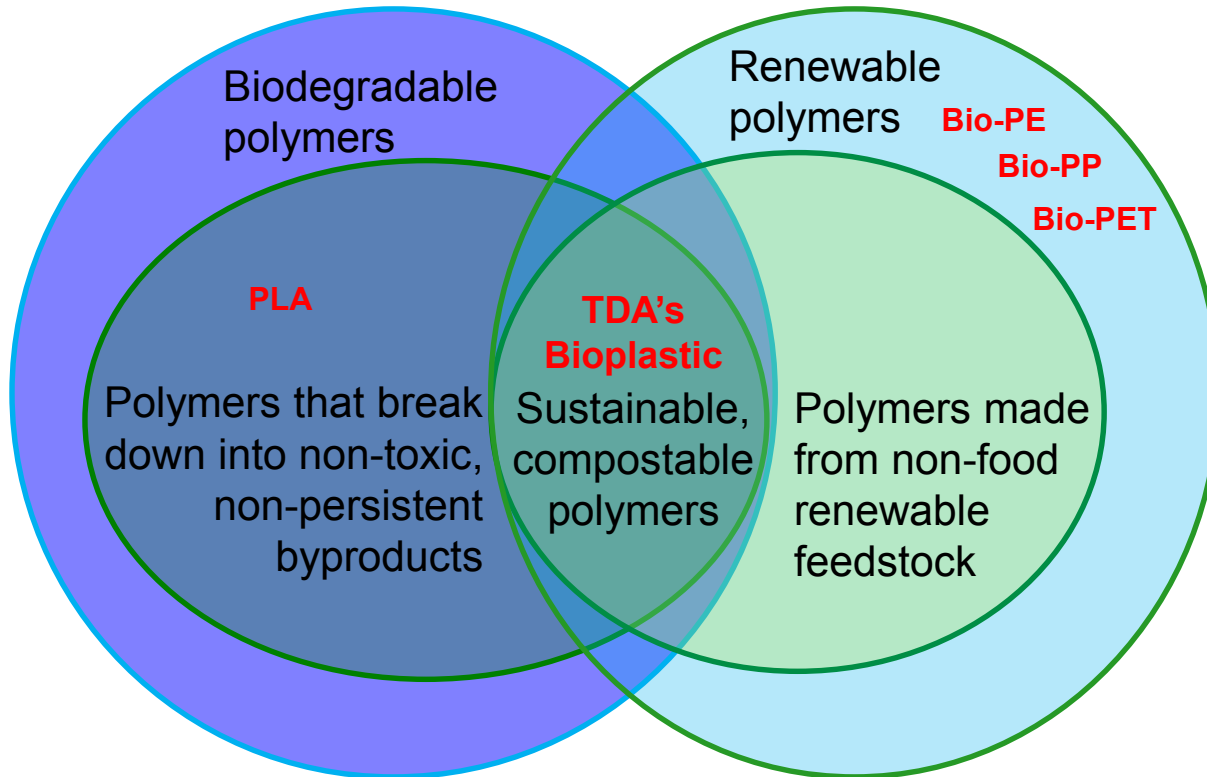
US Patent # 9,040,635

*“Renewable Polymer and Method of Making”*



# Benefits - “Waste” Source Degradable Polymer

Solvent-less process reduces energy use  
and waste products



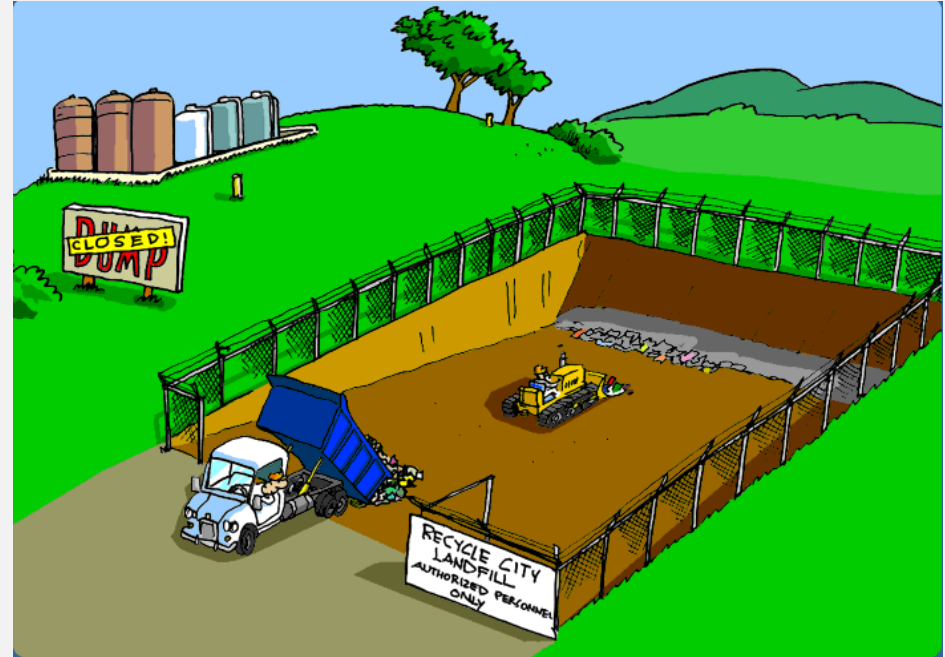
- Original process involved solvents and exotic catalysts
- Current process uses **NO** solvents and readily-available catalyst

# Benefits – Let's Think Landfill

Degradation time of plastic shopping bags decreased by **up to 96%**

## Estimate of Years to Degrade

- Polyethylene – 500 years
- PDHDO
  - 14 years (pH 7)
  - 5 years (pH 2)



*Biodegradable polymers...  
Reduce degradation time,  
Environmentally friendly...*

# LDPE Market

Market Size Estimates  
[annual]

Global LDPE Market  
\$33 B (2013)  
→ \$37 B (2021)



Food storage, film, plastic  
wrap, bags, containers

TDA's 1<sup>st</sup>  
opportunity  
\$30 MM

Bio-derived plastics and  
biodegradable demand  
expected to increase

All bioplastics  
\$3.4 B

Disposable product wrap  
for diaper bags

Our product is a novel, renewable, and compostable  
replacement LDPE thermoplastic

# Where Are We?

## *In-Lab production of PDHDO*

**TRL = 4**

*In-lab R&D results show promise for technology and profitable economics*

Original process involved more expensive solvent and exotic catalyst



Simpler polymerization route to make PDHDO was successful with low-cost catalyst



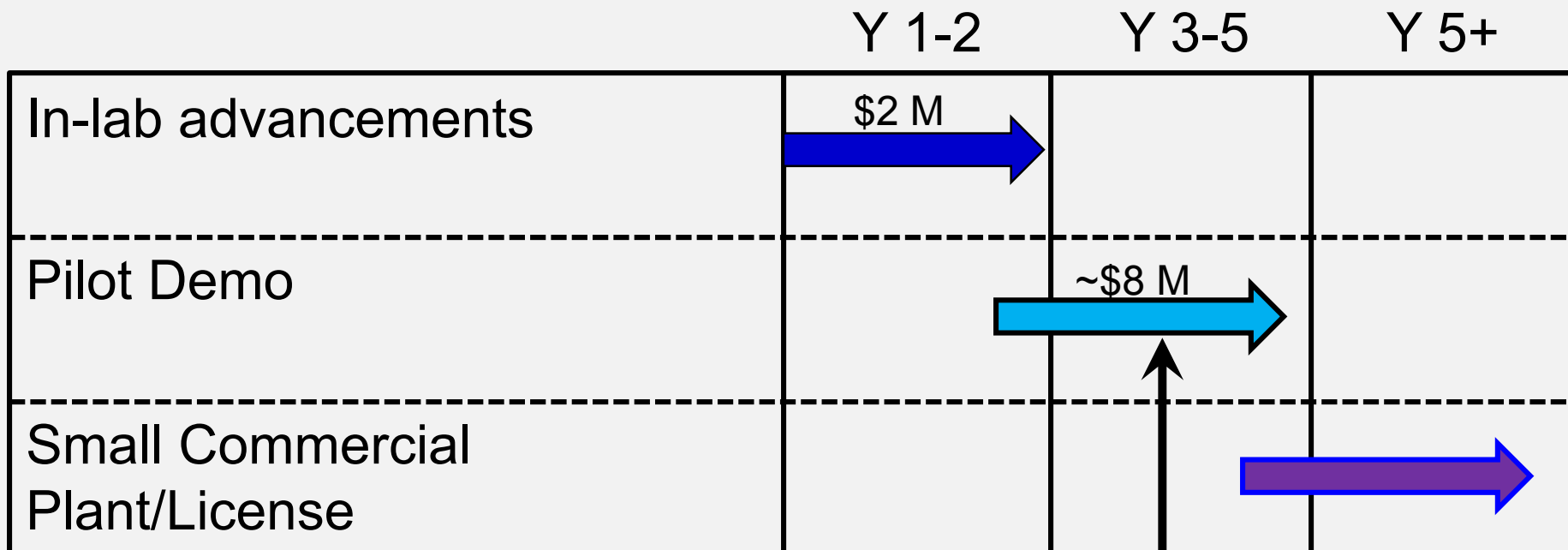
# Next?

## Regulation and Certification Approvals

- EPA Approval - Toxic Substance Control Act (TSCA)
- *Biodegradability testing and certification – ASTM D6400*
- *Characterization and certification of properties to match LDPE as drop-in replacement*
- Build relationships with end customers to tune characteristics for durability, manufacturability
  - *Have interest from large consumer products company to test product*

# Business Model and Timeline

**License** patent and know-how to polymer manufacturer



*Engagement with large polymer manufacturer to license technology*

# Capital Need - Pilot Plant Demonstration

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- Feedstock is available
- Pilot Plant demonstration cost estimate - \$10 MM for design, CAPEX, OPEX
- TDA will seek to leverage with DOE/USDA/EPA funds
- TDA is looking for scale-up and development partners

# Why Care?

- We are proposing a very SIMPLE business Model
  - Not capital intensive – no manufacturing plant
- Successful Pilot demonstration will lead to technology license
- Long-needed product (market pull)
- Spin-off a technology licensing company
- Payback estimated to start in **Year 5**
  - Revenues from licensing patent/know-how

## Growing renewable polymer market

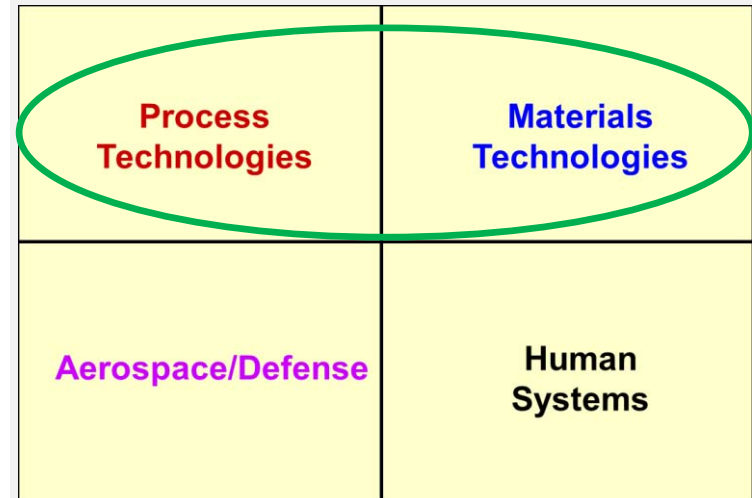
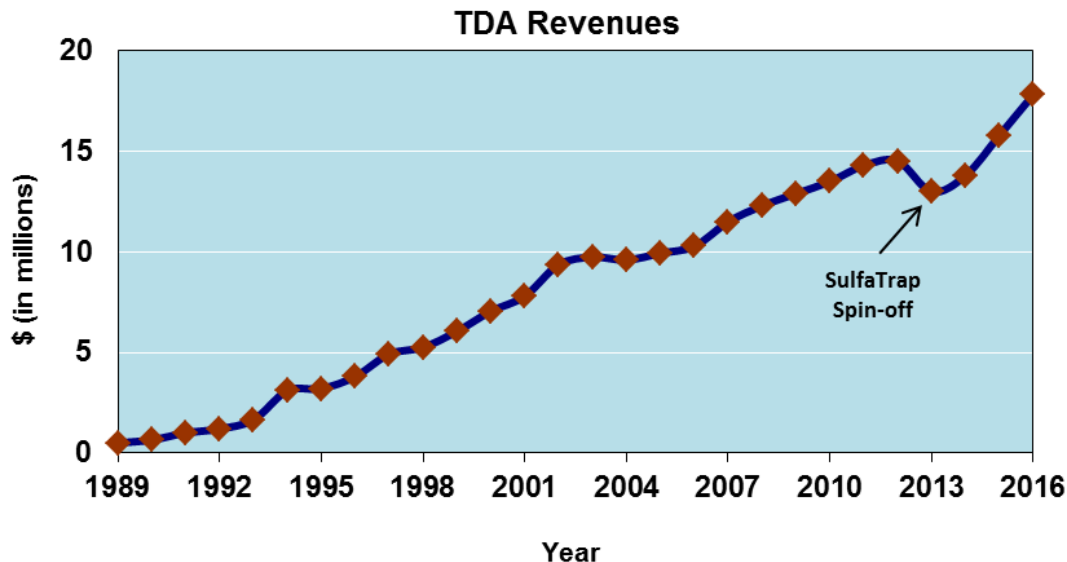
- \$3.5B/year
- Potential first adopter has been identified

# Why Invest?

- ***Innovative Technology***
- ***Strong Patent Position***
- ***Growing Market***
- ***Simple Business Model***
- ***Strong Fundamentals***
- ***Experienced Management***

# TDA - Strong Fundamentals

- TDA has been in business for ~30 years
  - No external debt
  - Profitable every single year
- *Has experience in licensing chemical/environmental technologies*
- *Spun-off a successful, ongoing business 4 years ago*



# Experienced Management

- **Equity closely held – active managers**

- 80 employees
- 27 Ph.D.'s -chemistry/engineering

- **Facilities**

- Combined 50,000 ft<sup>2</sup> laboratory and office space near Denver, Colorado

- **Management**

[Girish Srinivas](#), Ph.D., MBA – VP Business Development

[Gokhan Alptekin](#), Ph.D. – VP Technology

[John Wright](#) – President



## Technical

[Bob Bolskar](#), Ph.D., Principal Scientist

[Jim Raebiger](#), Ph.D. – Senior Scientist

Each has 25 - 40 years of technology development and commercialization experience

# Questions?

