RESPONSIBLE MANUFACTURING approach for Fluoropolymers

Cedric Triquet
Global Strategy and Advocacy Director
Advanced Performance Materials

AGENDA

01
Overview of Chemours

02
Fluoropolymers – Enabling Sustainable Innovation

03
Fluorinated Organic Emissions Reduction

04
Non-Targeted Analysis & Processing Aids Technologies

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01

OVERVIEW OF CHEMOURS

The Chemours Company

OUR PURPOSE

Chemours is a different kind of chemistry company, driven by our purpose to create a better world through the power of our chemistry.

OUR BUSINESS UNITS

- TITANIUM TECHNOLOGIES
- THERMAL & SPECIALIZED SOLUTIONS
- ADVANCED PERFORMANCE MATERIALS

Chemours 10X2030

We're building a more sustainable future through our Corporate Responsibility Commitment goals

Built upon a 200-year-old legacy, product portfolio, and innovation

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Our Corporate Responsibility Commitment

CORPORATE RESPONSIBILITY COMMITMENT

We announced 10 bold goals in 2018 to bring responsible chemistry to life by 2030.

BOLD EMISSION GOALS

We aim to achieve net-zero Greenhouse Gas Emissions (GHGs) by 2050, with an interim target of 60% absolute reduction of operations-related GHGs by 2030.

LEADING BY EXAMPLE

Committed to 50% of our revenue coming from products that positively impact UN Sustainable Development Goals.

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FLUOROPOLYMERS

Enabling Sustainable Innovation

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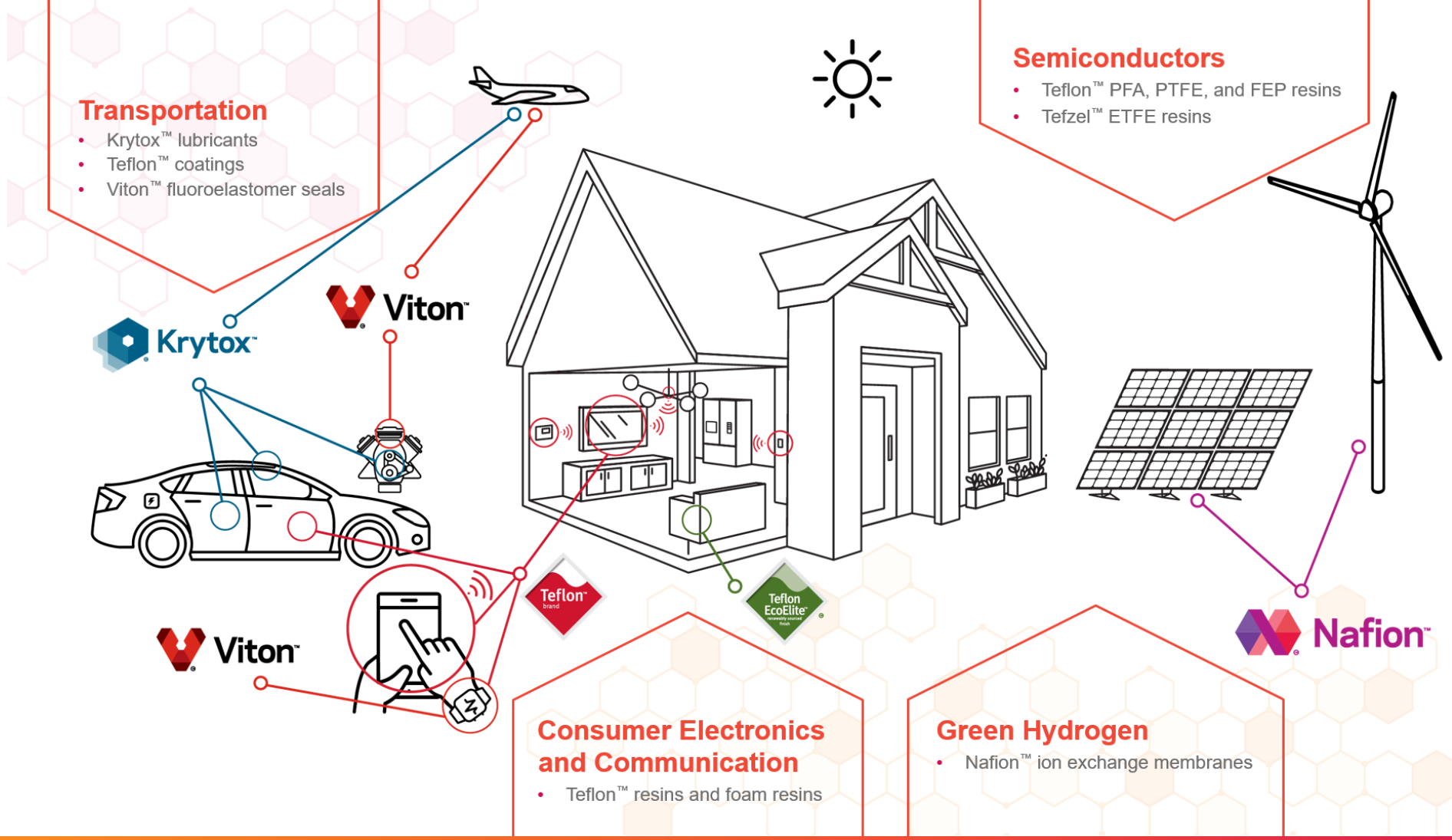

Solving the World's Most Challenging Problems

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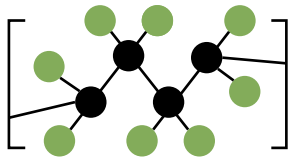
Fluoropolymers

Polymers of Low Concern with High Societal Value

POLYMERS

Fluoropolymers

Carbon-only polymer backbone with fluorines directly attached



Fluorine Carbon

Teflon™ Nafion™ Viton™

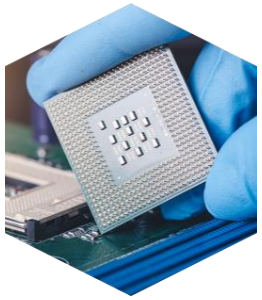
RELEVANT PROPERTIES

Thermal, chemical and biological stability*

High Molecular Weight;
Not bioavailable or subject to long-range transport

Fluoropolymers shown to meet OECD Polymer of Low Concern (PLC) criteria*

IEAM **2018**, 14(3):316-334 Open access: http://dx.doi.org/10.1002/ieam.4035
IEAM **2022,** Open access online ahead of print: https://doi.org/10.1002/ieam.4646



Fluoropolymers have a unique combination of properties that no other material has. That makes them critical materials for production of semiconductors, the automotive industry today and future electrification of vehicles, and making the hydrogen economy a reality…to name a few.

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03

Fluorinated Organic Chemical (FOCs) REDUCTION

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Sustainability Goals
Decarbonization and FOCs

DECARBONIZATION

EMISSION REDUCTIONS

RENEWABLES

ENERGY EFFICIENCY

FLUORINATED ORGANIC EMISSION REDUCTIONS

AIR

WATER

Shared Planet

Climate
- Reduce absolute greenhouse gas emissions from operations by 60%
- Journey to net-zero operations by 2050

Water
- Reduce air and water process emissions of fluorinated organic chemicals by 99% or more

Waste
- Reduce our landfill volume intensity by 70%

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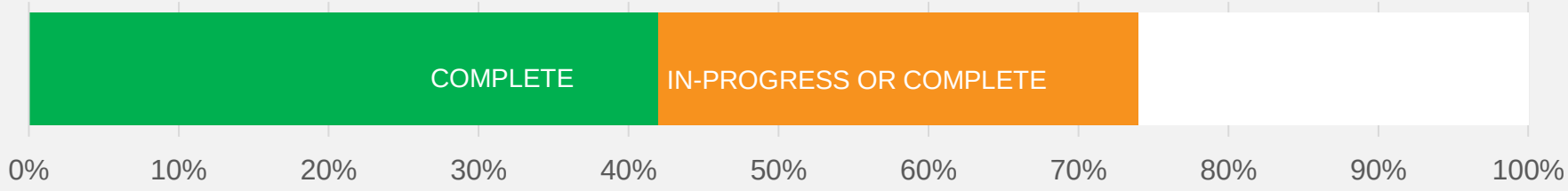
Fluorinated Organic Emission Reductions

- Analytical detection capability
- Roadmap development
  - Recycle / re-use / circular
  - Thermal destruction of the fluorine – carbon bond
  - Capture the FOC for thermal destruction
- Define roadmap gaps & begin to close the gap to 99%
  - 24 projects completed, and an additional 20 projects are currently in progress.

PROGRESS TO 99%



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Key Technologies

FOC Reduction

- Direct thermal destruction of concentrated FOCs
  - Demonstrated >99.99% destruction efficiency.
- Adsorption for dilute vapor streams of ‘higher boiling’ compounds
- Advanced fugitive emission detection and controls
- Development: dilute vapor streams containing ‘low boiling’ compounds

- Reverse Osmosis, ion exchange, carbon adsorption, thermolysis
- Development: process water recycle, regeneration of media

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Responsible Manufacturing

HOW WE ARE TAKING ACTION

By 2030 we aim to reduce air and water process emissions of fluorinated organic chemicals by 99% or greater.

In last 3 years, 75 M$ investments in Dordrecht Works with Air and Water abatement systems allowing to decrease HFPO-DA emissions by > 99.9%

- In 2020, we successfully deployed our thermal oxidizer at our **Fayetteville Works** facility which destroys 99.999% of PFAS emissions and represents a $100 million investment in emissions control technology.
- At Fayetteville, greater than 85% of greenhouse gases have been eliminated to date. This is equivalent to more than 500,000 mT CO_2e reduction.

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04

NON-TARGETED ANALYSIS & PROCESSING AIDS TECHNOLOGIES

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Polymerization and Non-Targeted Analysis

- During polymerization, fluorinated residuals, i.e. PFAS, can be created through inefficient side reactions.
- Residual concentration depends on several parameters including:
  - Polymer type (PTFE, FEP, PFA, FKM, etc…)
  - Manufacturing technology
  - Polymerization Aid technology (fluorinated, non-fluorinated, or no polymerization aid at all)
- Interrogation by **Non-targeted** analysis, however, provides a more comprehensive interrogation of the sample detecting analytes otherwise not captured through **targeted** studies alone.

Understanding Non-Targeted Analysis

Targeted Analysis

Only searches for known substances, this can be about 70 PFAS substances—missing potentially countless other unknown byproducts.

Targeted analysis does allow for the measurement of the exact quantities of those targeted substances.

Non-Targeted Analysis

Allows the tester to identify all potential byproducts.

With this information, a targeted analysis may be developed for an identified compound to determine exact quantities.

As an example:

If you are asked to count how many birds are in the jungle. Targeted analysis is searching for parrots in the jungle: no parrots means no birds. Non-targeted is searching for birds: so even if you find no parrots, you may still find other birds, and therefore conclusion from targeted analysis is incorrect.

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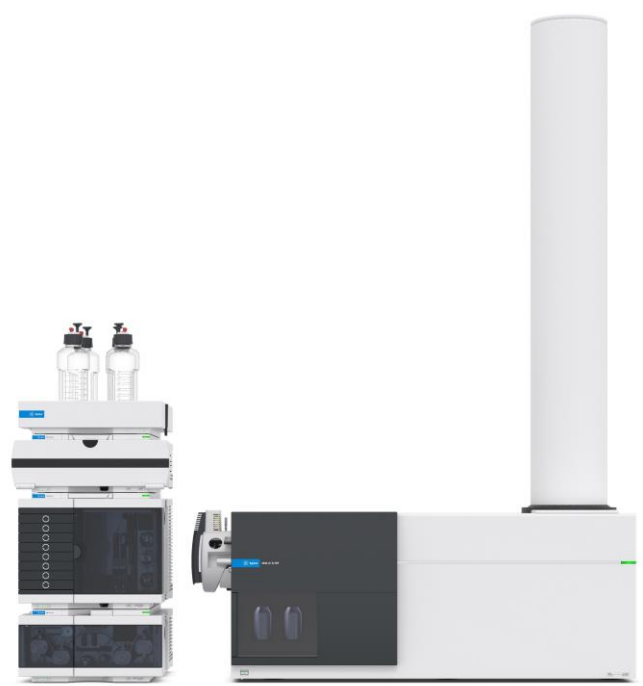
Non-Targeted Analysis

- Liquid Chromatography Tandem Mass Spectrometry Quadrupole Time of Flight (LC/QToF)
- Sample preparation is a key element since required detection limits are at ppb level or below:
  - Cannot afford contamination
  - Need to concentrate samples to reach required detection levels
- Can observe many peaks that need to be filtered to the relevant fluorinated detects, analyzed to generate empirical formulas, and appropriate structures proposed based on the relevant chemistry
- Quantitation is challenging since authentic standards are not available, but proxy standards can be utilized to estimate concentration



Agilent 6546 LC/QToF
(Courtesy of Agilent at www.agilent.com)

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Polymerization Aids Technologies

- Non-Fluorinated Polymerization Aids/Surfactants (NFPA/NFS) are **NOT** the solution to responsible manufacturing.
  - They cannot produce the complete portfolio of fluoropolymers society needs
  - They can create residues that need emission controls
  - Fluorinated Polymerization aids remain crucial for high-performance applications

> According to the **U.S. EPA** has in manufacturing, "even when non-fluorinated surfactants are used as a polymer processing aid, low molecular weight polymer byproducts are generated and can be significant contributors to PFAS waste concentrations."

Whatever polymerization technology is being used, state-of-the-art emissions control technologies are required

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THANK YOU!