



Radel® PPSU magnet wire for power grid

a more sustainable solution with a
lower carbon footprint than
today's enamel magnet wire.

Roberta Colombo

Marketing Manager

Power Grid & Charging Infrastructure



Visit us at **Stand 4.2 F27**

Table of Contents

1

Intro

2

Syensqo

Group Overview

3

Your Partner for
Innovation

Application Driven
Development: beyond the
polymer science

4

Radel PPSU

ThermoPlastic Resins for
Electrical Insulation
Applications

5

A 30 years
successful story

REA MagneFlex

6

Key Takeaway



Roberta Colombo

Marketing Manager Transportation
Electrical Power Grid and Charging Infrastructure

I work **cross-functionally with R&I to design innovative new products for the next generation of transformers** and more widely for electrical machines.

I leverage my technical expertise to **work directly with the players in the electrical power grid value chain** to identify and bring solutions to respond to the growing electrical power demand.



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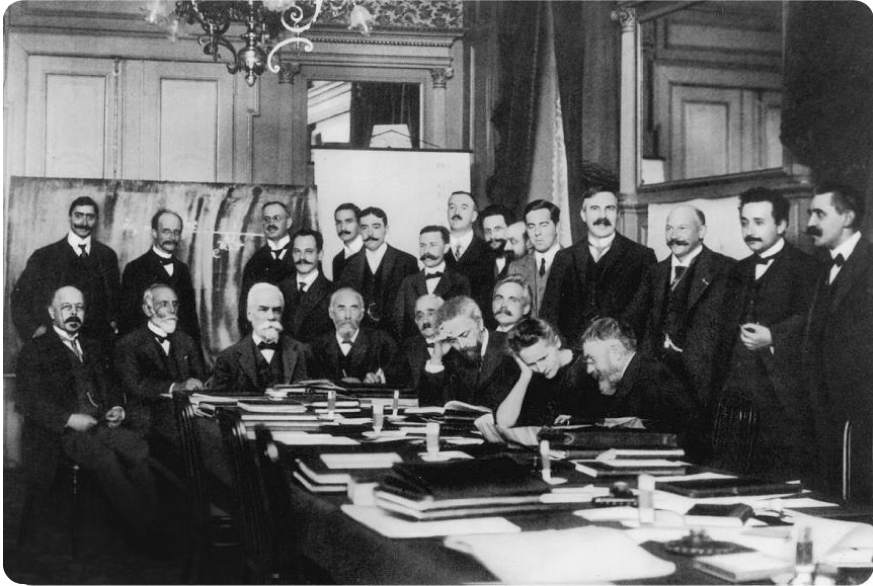
Scan the QR-code for
my contact information





SYENSQO

Our foundations

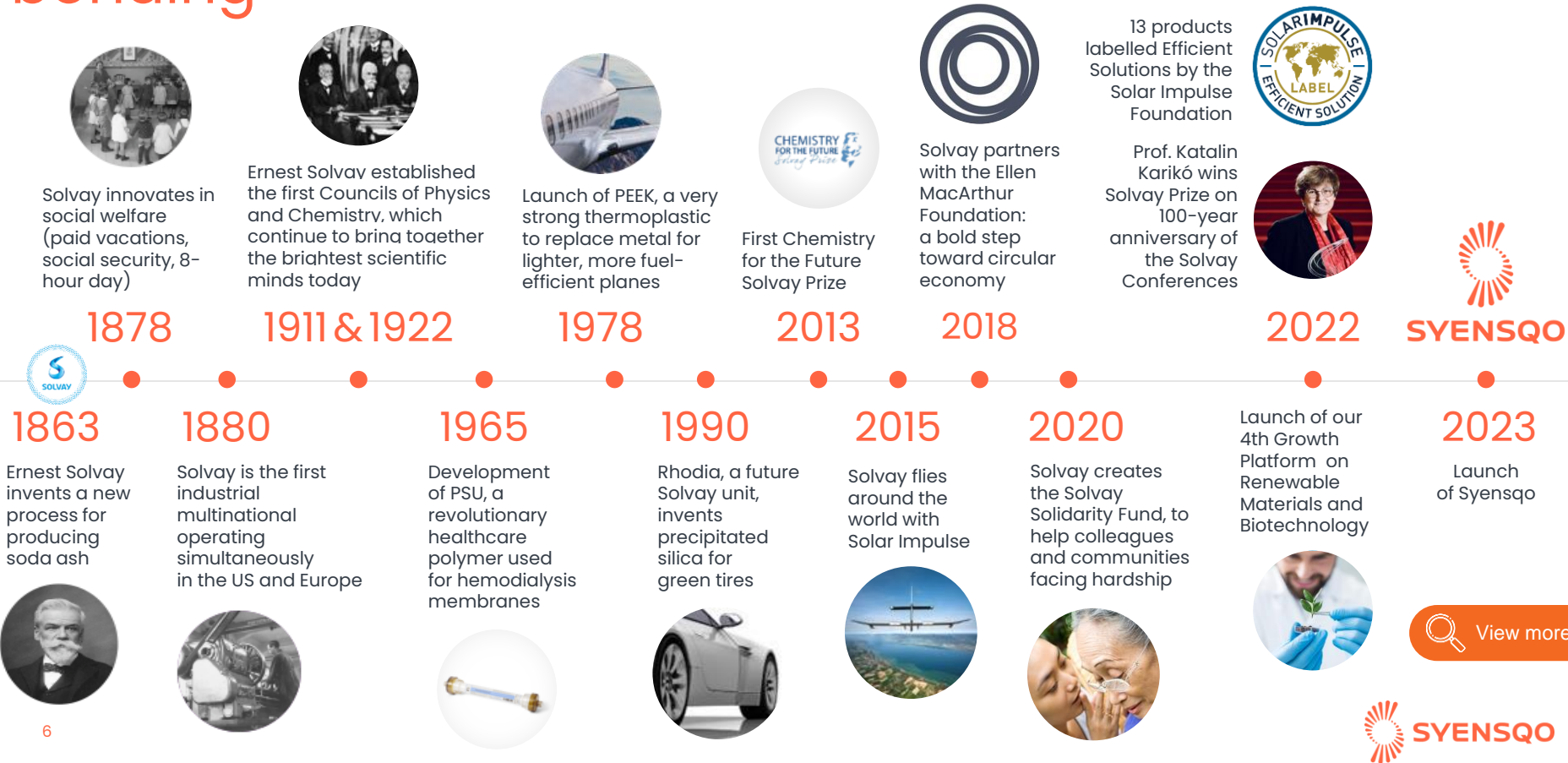


The **Solvay Conference of 1911** stands as a beacon of visionary thinking and collaboration. Ernest Solvay brought together 24 of the world's most brilliant scientific minds together - including Albert Einstein and Marie Curie.

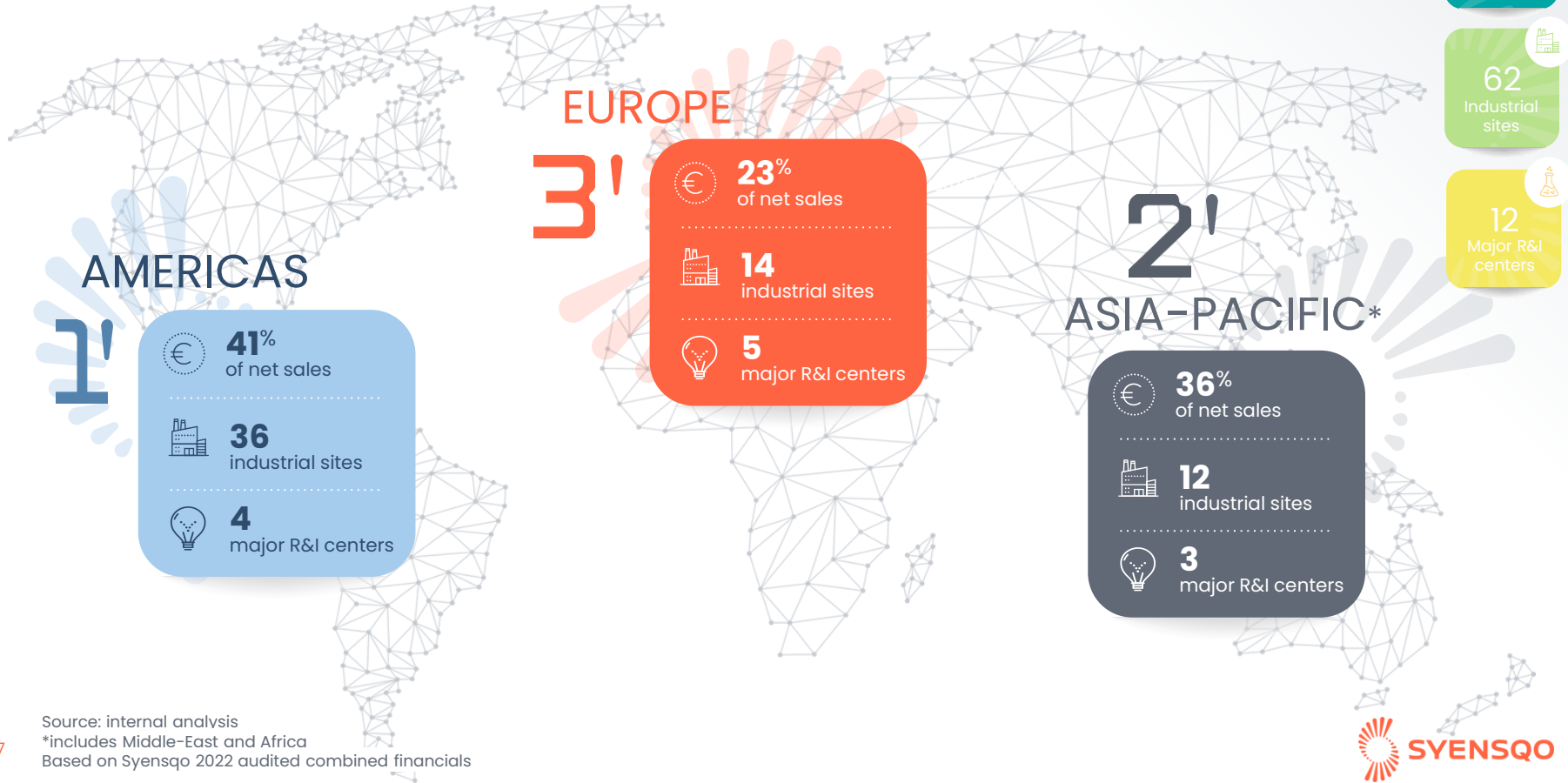
It was more than just a meeting of brilliant scientists—it was an **extraordinary convergence of explorers**, driven by a shared passion for unraveling the mysteries of the universe.

In the spirit of those pioneering minds, **Syensqo emerges as a brand that embraces the legacy of the Solvay Conference**, embodying the same adventurous spirit and forward-thinking mindset. Like those intrepid explorers who dared to push the boundaries of what was known, **Syensqo is embarking on its own odyssey of scientific discovery, exploring new territories and discovering transformative ideas.**

A pioneering legacy and a passion for science and bonding



Global and close to our customers



Source: internal analysis

*includes Middle-East and Africa

Based on Syensqo 2022 audited combined financials



Your Partner for Innovation

Advanced Material Solutions

Our offer

Syensqo

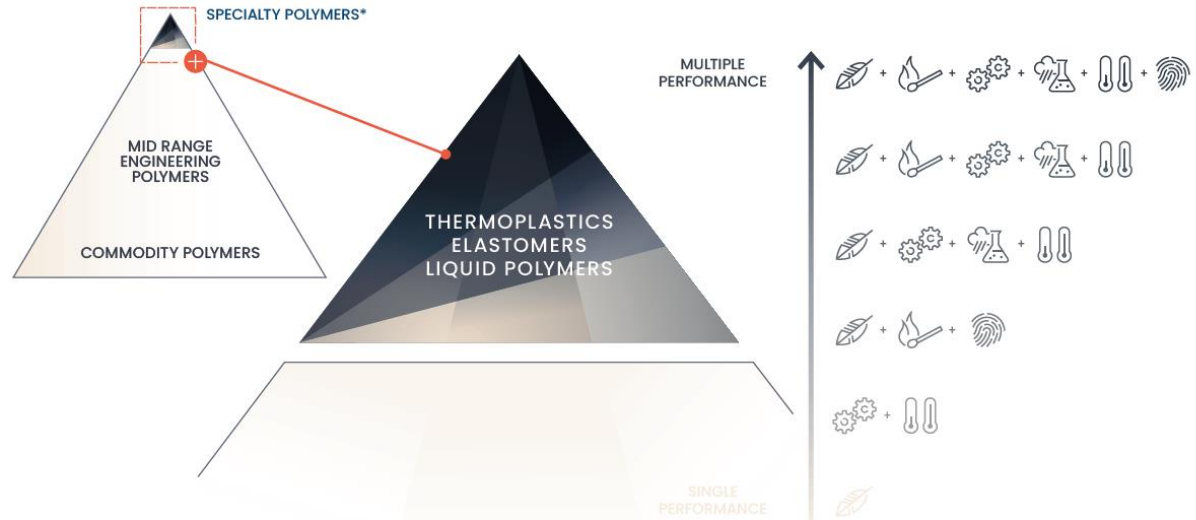
manufactures the industry's **broadest selection of specialty polymers, which includes high-performance thermoplastics, fluids and Elastomers.**

Your benefit

The wide portfolio makes it possible for our customers to **work with a single supplier to solve a wide variety of design challenges.**

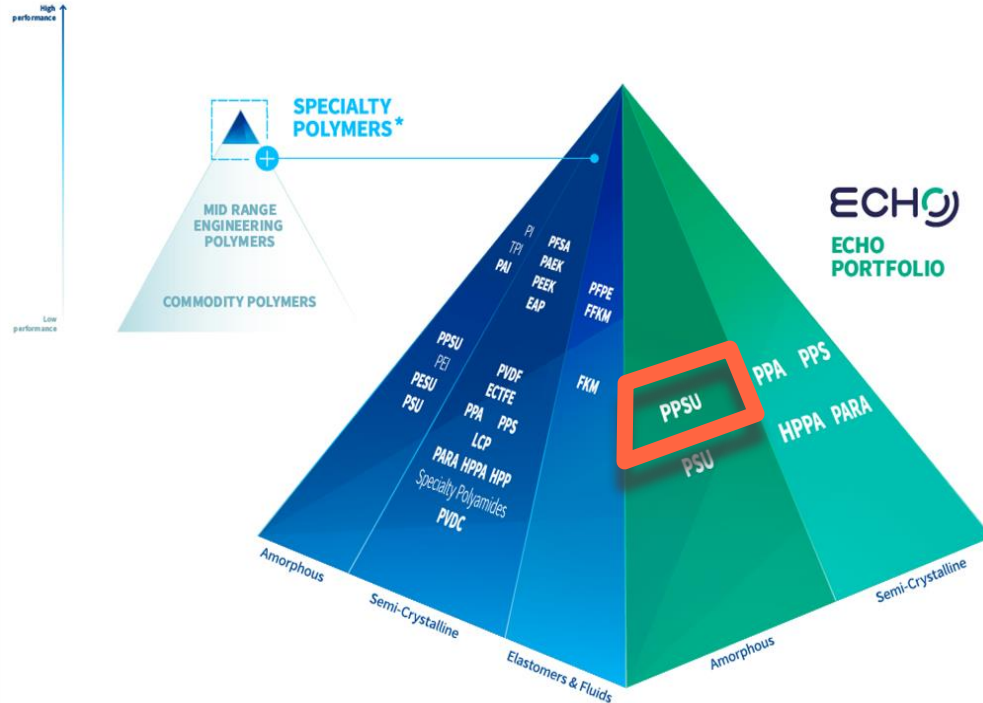
Specialty

Specialty polymers are characterized by their ability to retain desirable mechanical, thermal, and chemical properties when subjected to harsh environments. Depending on the product, they also offer fatigue and wear resistance, flame retardant properties, corrosion protection, electrical inertness and dimensional stability.



Meet our ECHO Portfolio

More Sustainability, same performance



ECHO portfolio empowers the **ambition** towards a **carbon-neutral future**. This comprehensive selection of sustainable solutions is engineered with **bio-based, recycled, and mass balance certified raw materials**.

Delivering a performance equivalent to their originating counterparts, ECHO technologies provide high-quality, sustainable alternatives to reduce the industry's environmental impact.

Sustainability and circularity are at the core of how we design our technologies, manufacture our products, and ultimately work with our customers to reduce both our and their carbon footprints.

Application Development

A new collaboration Model

APPLICATION DEVELOPMENT

STRATEGIC INITIATIVE

dedicate to anticipate solutions for tomorrow challenges of MEGATRENDS

DESIGN

VIRTUAL ENGINEERING

Advanced part/system simulation and emerging technologies
Support material characterization



SYENSQO

+

CUSTOMERS

PROTOTYPING

PART MANUFACTURING

Extrusion (Film, Wire, Pipes),
Injection & Overmolding, Thermo-
Forming and Coating

PERFORMANCE

MATERIAL & PART TESTING

Advanced mechanical, thermal,
chemical, electrical and aging testing



SYENSQO

4

Radel® PPSU

Radel® PPSU

Benefit

MATERIALS

Excellent Electrical Insulator

Good Mechanical Performance

High Thermal Stability

High Chemical Resistance

Intrinsically Flame retardant

Easy extrudability

No solvent content

Less Energy-Intensive process

Wide range of coating thickness

PROCESSING

Radel® PPSU is an **amorphous thermoplastic resins** that offers high performance in **wire insulation applications.**

Radel PPSU on Aluminum Conductor



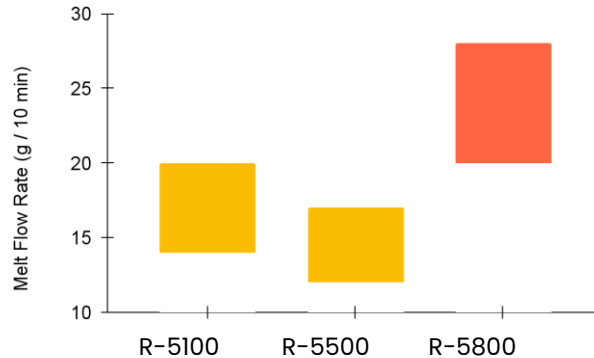
Radel PPSU on Copper Conductor



Radel® PPSU portfolio

Form		Pellets
Density	g/cm ³	1.29
Glass Transition Temperature	°C	220
Volume Resistivity	ohms*cm	9E+15
Dielectric Constant ⁱ		3.45
Flame Retardant		V0

Viscosity
MFRⁱⁱ



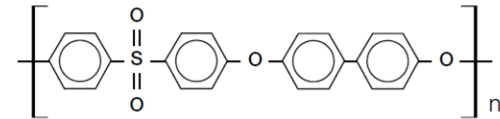
ⁱ - 3.18 mm, 60 Hz

ⁱⁱ - ASTM D1238

Radel® PPSU is an **amorphous thermoplastic resins** that offers high performance in **wire insulation applications**.

Radel® PPSU

PolyPhenylSulfone



Radel® PPSU in Transformers

MATERIALS

Excellent Electrical Insulator
Dk 3.45

Good mechanical performance

High Thermal Stability

Low dissipation factors

Resistance to Transformer Oils

Intrinsically Flame Retardant

TRANSFORMER

Benefit

Design Freedom to reduce space
by designing more Compact
Devices

**High Flexibility &
Fairly Easy to Strip** for Terminations

High Tan Delta

Thermal Class - 200°C
Low dissipation factors < 2% at 150°C
HDT = 207°C

For Oil Immersed Transformers
but **not limited to**

V0 - UL94

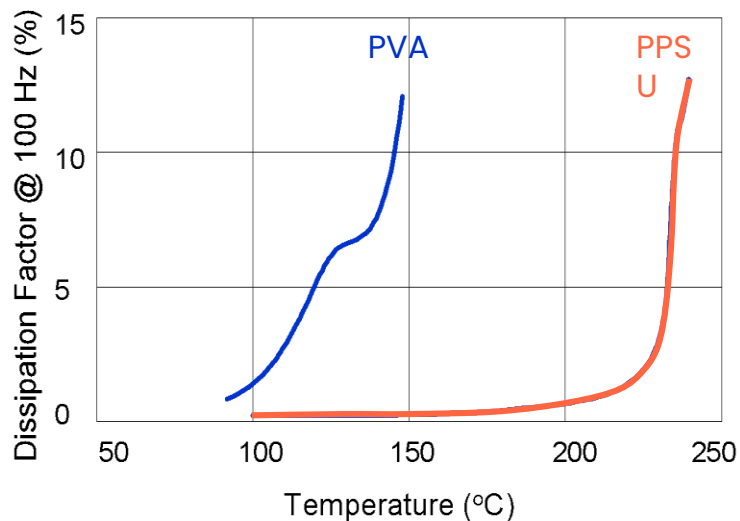
Radel® PPSU is a good
candidate for **wire
insulation in power grid
applications.**



Sample Courtesy of REA MAGNET WIRE

Radel® PPSU in Transformers

Low dissipation factors < 2% at 150°C

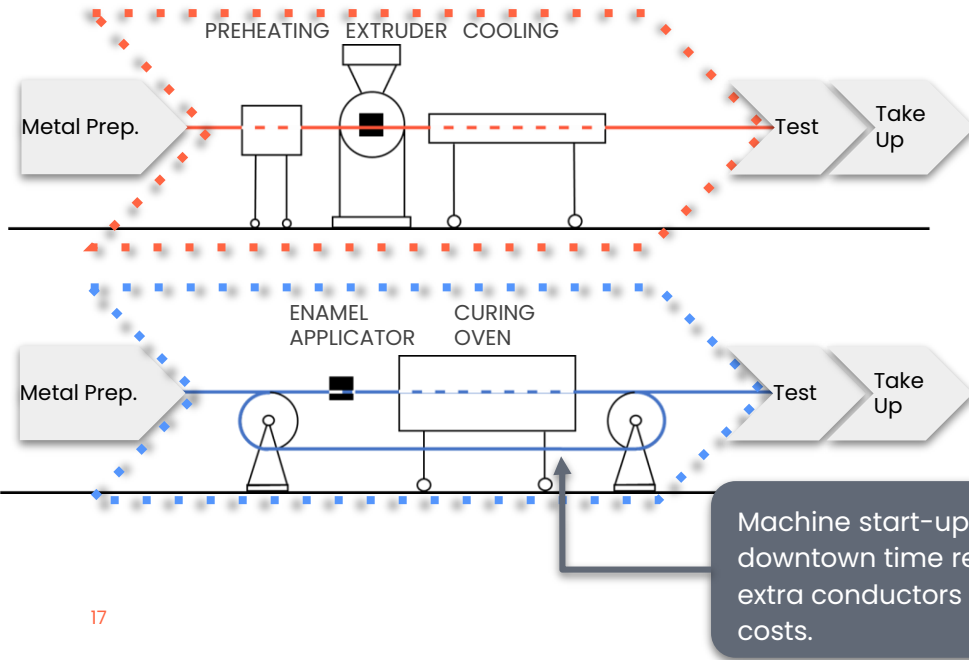


With a Tan Delta > 200°C Radel PPSU magnet wire offers a safety margin for the new transformers design.

Solvay INSUCON Presentation (2002) Foster and Boatwright, 1994
Data Courtesy of Hanover Manufacturing Corporation

Thermoplastic vs Enamel: Easier Processability

Radel® PPSU is an **amorphous thermoplastic resin** applied by **wire extrusion**.



PROCESSING

Easy extrudability with **conventional extrusion equipment**

100% Solid Content → **Max Build-up**

Cost efficiency by **1 step coating processing**

Thermoplastic vs Enamel: Energy and Emission

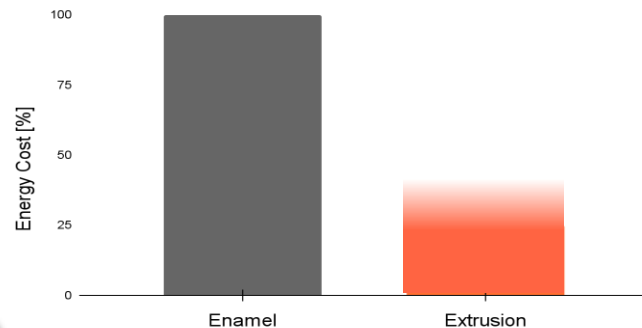
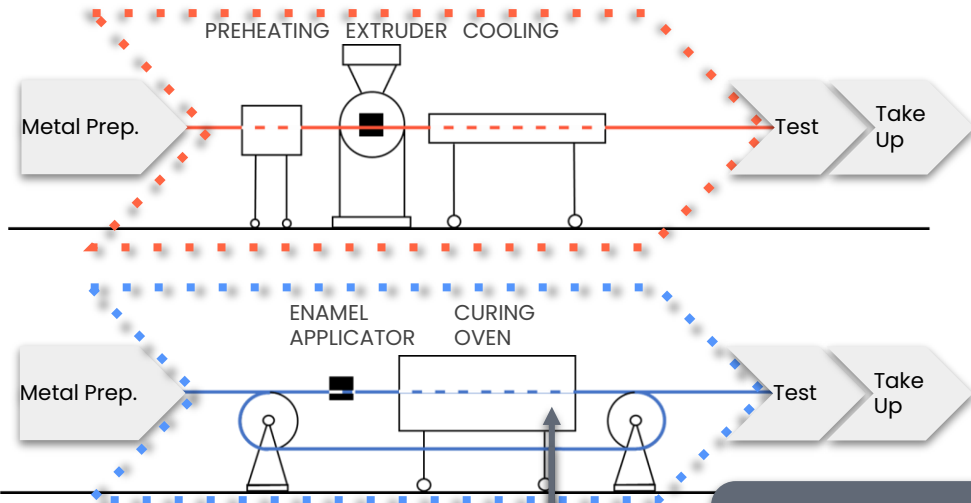
Radel® PPSU is an **extrudable resins**:



100% solid content with NO solvent release



NO curing step → energy saving.



Enamel Curing is
Energy-Intense
process

60-70% of enamel varnish
must be burn with high energy
cost and huge impact on CO_x-
NO_x emissions

Radel® PPSU & Transformer LifeTime

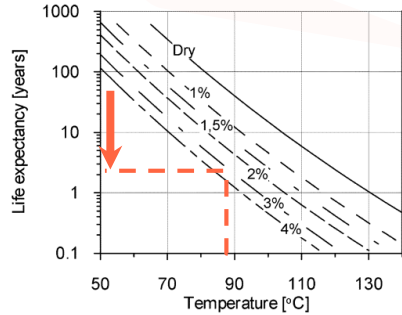


Fig. 13. Expected life for solid insulation and its dependence upon moisture and temperature.

IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 19, NO. 1, JANUARY 2004

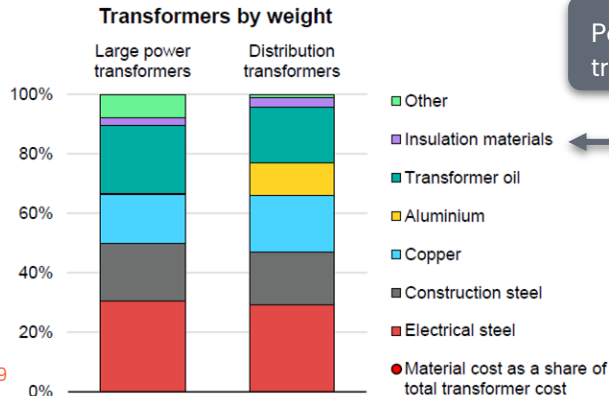
Insulation Layer	Oil Pollution*
Electrical Paper	Impacting Oil Quality
Radel PPSU	High Chemical Resistance

*A humidity of 4% can shorten a transformer's operational lifetime by a factor of 40 (i.e., by 97.5%)

The oil-immersed transformers lifetime is significantly impacted by the insulation degradation

Radel PPSU minimize the degradation risk, reduce the maintenance shutdown time and related cost.

Paramount impact on transformers failure



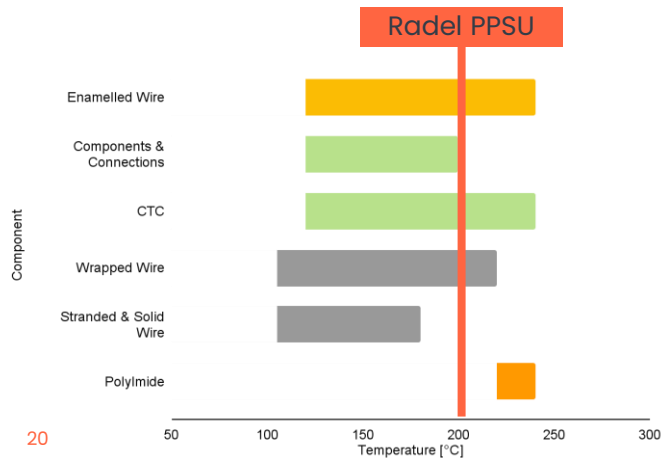
Radel® PPSU & Thermal Conductivity

Insulation Layer Thermal Conductivity

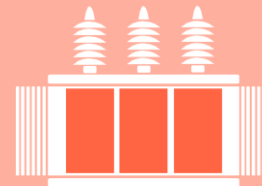
Electrical Paper 0.15 W/m*K

Torlon PAI 0.25 W/m*K

Radel PPSU 0.35 W/m*K



In addition to improving copper slot fill, the higher thermal conductivity allows better heat transfer away from the magnet wire.



Radel® PPSU film

Mechanical & Electrical Performance

Ajedium™ PPSU – Thickness 100 µm



Property*	Test Method	Units	Performance
Tensile Modulus	ASTM D882 ⁱ	kpsi	328
		GPa	2.26
Tensile Strength at Break	ASTM D882 ⁱⁱ	kpsi	11
		MPa	76
Tensile Elongation at Break	ASTM D882 ⁱⁱ	%	140–150
Column Strength		N	8–10
Breakdown Voltage	ASTM D149	kV – 23°C	11.8
Dielectric Strength	ASTM D149 ⁱⁱⁱ	kV/mm – 23°C	116.71
PDIV	ASTM D1868 ^{iv}	V _{peak} – 23°C	1158

* PRELIMINARY TDS

ⁱ – Grip Separation: 2", Strain Rate: 10 in/in-min

ⁱⁱⁱ – 1/2" diameter cylindrical electrodes, 500 V/s rise rate


ⁱⁱ – Grip Separation: 10", Strain Rate: 0.1 in/in-min

^{iv} – 25mm cylindrical electrodes, 20 V/s rise rate, 5 pulses > 100 pC

- The high mechanical Strength and Flexibility made the Radel PPSU the right candidate for the Transformer magnet wire.
- Radel PPSU can be film extruded too with a range thickness down to 25 µm.

Radel® PPSU ECHO

More Sustainability,
same performance



Circular Nature

Mass balance feedstock (PIR)*



Renewable Electricity

✓ 100%
(resin + compounding)



Fossil Substitution

Up to 38%



Product Carbon Footprint Reduction

Up to 7%



>80%
of Innovation
pipeline focused on
sustainable solutions

*Using mass-balanced recycled & bio-circular resins from technical and/or bio wastes. Mass-balance attributed with ISCC-PLUS certification

5

A 30 years
successful story


Rea MagneFlex: a successful case on the market

MAGNEFLEX represent a product family of aluminum conductors insulated with a Radel® PPSU.

Insulation Material



Radel® PPSU

 number E36098




Sample Courtesy of REA MAGNET WIRE

Magnet Wire



REA MagneFlex

 number E130577



It was introduced in 1994,
with a **30 year successful story.**

Transformer

Application: Transformer

- General
- Utility Distribution Transformers
- Utility Power Transformers
- Specialty Transformers



Rea MagneFlex

DESIGN

INSULATION: Radel® PPSU
THERMAL CLASS: 200 °C
CONDUCTOR: Aluminum
Typical SHAPE: Round 2-6 AWG
 Shaped Width 3.2-17.8
 Thickness 1.9-8.9

INSULATION Thickness: 0.1-0.25 mm

FEATURES AND BENEFITS

Provides **uniformity of insulation thickness**
Excellent **resistance to stress cracking**
Excellent **dielectric properties**
Up to **100% reduction in test failures**
Increased **winding speeds**
Lower water absorption
Lower total unit cost
Extremely durable
Easy to strip

REA MagneFlex represent a reliable and sustainable application case of thermoplastic resin as electrical insulation for Power Distribution Transformers market.



Sample Courtesy of REA MAGNET WIRE



Key Takeaways

Key Takeaways

Radel® PPSU is an **amorphous thermoplastic resins** that offers high performance in **wire insulation applications** for **Power Grid Applications**, and represent a **more sustainable solution than today's enamel magnet wire technology**.

PERFORMANCE

Radel® PPSU offers excellent Electrical Insulation Properties combined with high mechanical performance and resistance to insulating oils.

It ensure **High Flexibility** & Fairly Easy to Strip for Terminations.

With **Thermal Class 200°C** it offers a **safety margin for new transformers design vs std enamel**.

It **minimize the transformer oil degradation risk**, with benefit on the transformer lifetime, the maintenance shutdown time and related cost.

SUSTAINABILITY

Radel® PPSU can be easily extruded by conventional extrusion equipment, with significant energy savings and no solvents.

100% solid content

- **NO solvent release and related COx-NOx emissions**
- **Max Build-up**

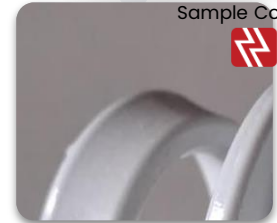
NO curing step needed, with benefit of a **lower energy-Intense process compare to enamel**

Cost efficiency by **1 step coating processing**

CASE HISTORY

REA MagneFlex represent 30ys application case of Radel PPSU

Sample Courtesy of





Thank You
& Don't forget to
visit us at **Stand 4.2 F27**



Scan the QR-code for
my contact information

