Interface & Performance

TEGO® RC Silicones

September 2024

EVONIK
Leading Beyond Chemistry

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- BL Interface & Performance

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Evonik TEGO® RC - a pioneer for UV curable silicone technology

Evonik Overview

- **Divisions**
- **Business Lines**
- **BL Interface & Performance**

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Leading Beyond Chemistry

That’s specialty chemicals.
And that’s where we’re among the best in class.

€18.5 billion sales*	**€2.49 billion** adjusted EBITDA*	**€1.17** dividend per share**
13.5 % adjusted EBITDA margin*	**~80%** of sales from leading market positions	**€856 million** investment in tangible assets
>34,000 employees	**108** nationalities	**€2.26** adjusted earnings per share*

* Fiscal 2022, ongoing activities

** Proposal to the Annual General Meeting in May 2023

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Our five divisions with their diverse business lines drive our innovation and success

EVONIK

- Specialty Additives
- Nutrition & Care
- Smart Materials
- Performance Materials
- Technology & Infrastructure

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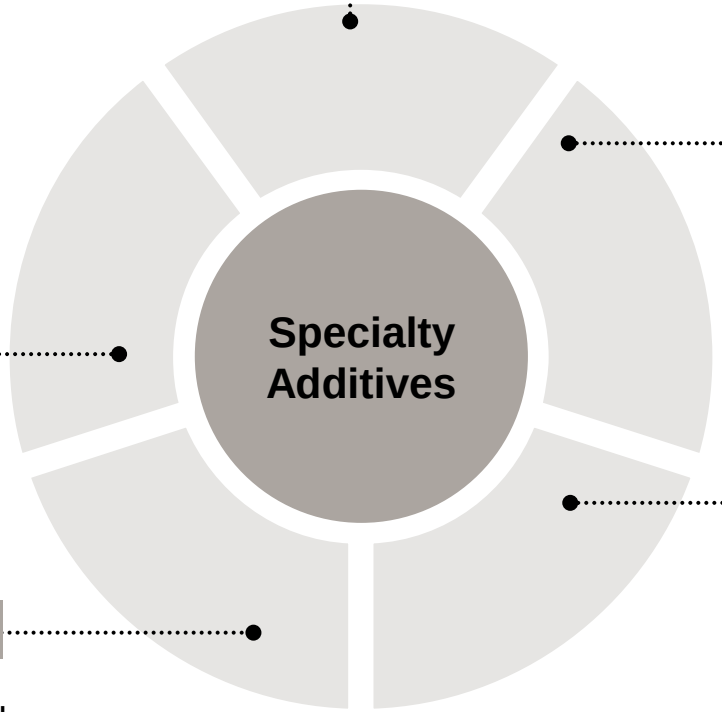
We offer integrated solutions

COATING ADDITIVES

The no.1 supplier of high-performance solutions for coatings and inks

OIL ADDITIVES

The preferred partner for innovative efficiency solutions in lubricants and adjacent fields



INTERFACE & PERFORMANCE

Leading innovator in the design of interface properties based on a broad technology platform

CROSSLINKERS

Leading global supplier of isophorone chemistry and technology leader in epoxy curing agents

COMFORT & INSULATION

Leading supplier of additives and innovative solutions for the polyurethane industry

Our main interfacial effects

Enabler for formulations in industrial markets and consumer end products

1 Dispersing

Create a homogeneous mixture with consistent properties throughout

2 Foam Control

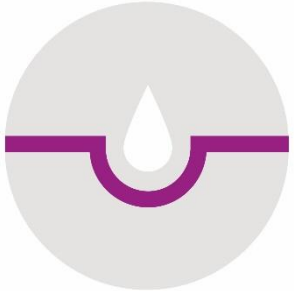
Control the foam in your chemical formulation or production processes

3 Releasing

Achieve the desired releasing effect

4 Surface Modification

Improve surface performance and maintain its properties



5 Wetting

Give formulations phenomenal spreading properties

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Technology

- Broad range of silicone and oleo-chemical to nanocomposite specialties
- Strong application know-how and competence
- Strong focus on sustainability

Cooperation

- High customer intimacy
- Long-term trusted relationships
- Global presence of sales and technical service
- Support via global test facilities and pilot plants
- Consulting on regulatory questions

Culture

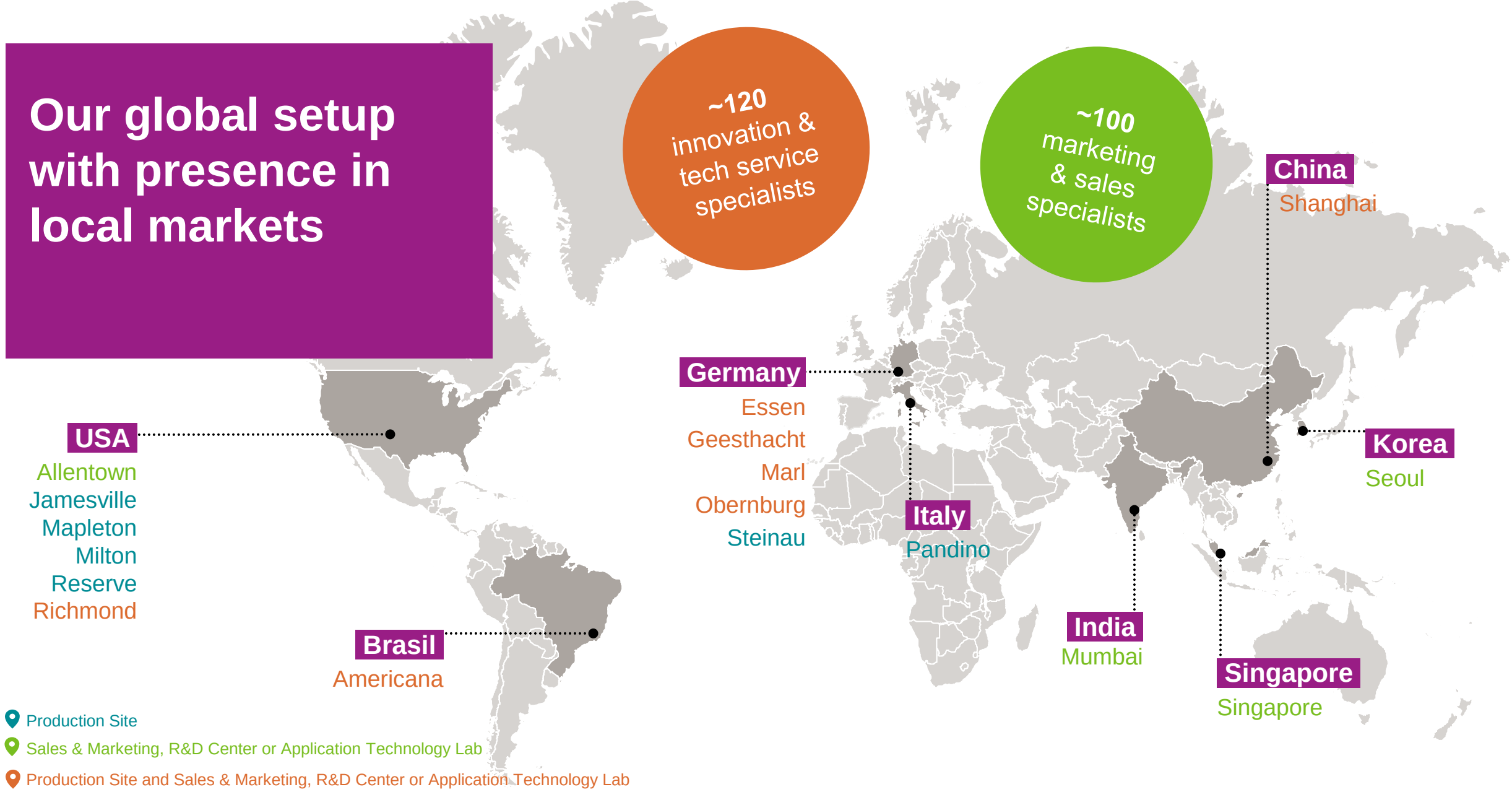
- Openness, trust, speed, performance
- Diversity
- Readiness for change
- Entrepreneurship and empowerment
- Operational excellence
- Digitalization

OUR DRIVERS
FOR YOUR BEST PERFORMANCE

Our global setup with presence in local markets

~120 innovation & tech service specialists

~100 marketing & sales specialists



USA
Allentown
Jamesville
Mapleton
Milton
Reserve
Richmond

Brasil
Americana

Germany
Essen
Geesthacht
Marl
Obernburg
Steinau

Italy
Pandino

India
Mumbai

China
Shanghai

Korea
Seoul

Singapore
Singapore

Production Site

Sales & Marketing, R&D Center or Application Technology Lab

Production Site and Sales & Marketing, R&D Center or Application Technology Lab

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Product Spotlight

Release Coatings

Industries

Personal hygiene, label, tapes, industrial and consumer electronics

Applications

Highly efficient UV curing release coatings for Pressure Sensitive Labels (PSA), tapes, hygiene products and many electronic, industrial and construction applications

Brands

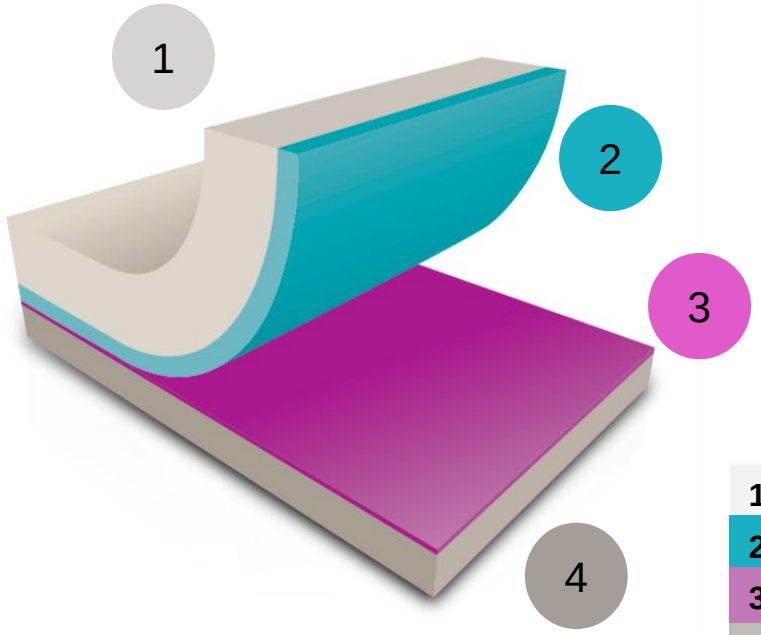
TEGO® RC

Main effects

Releasing

TEGO® RC Silicones

Construction of a Label Laminate



OI-AT-EME-RC:
2220162043

1) Label-face
2) Adhesive
3) Silicone
4) Liner

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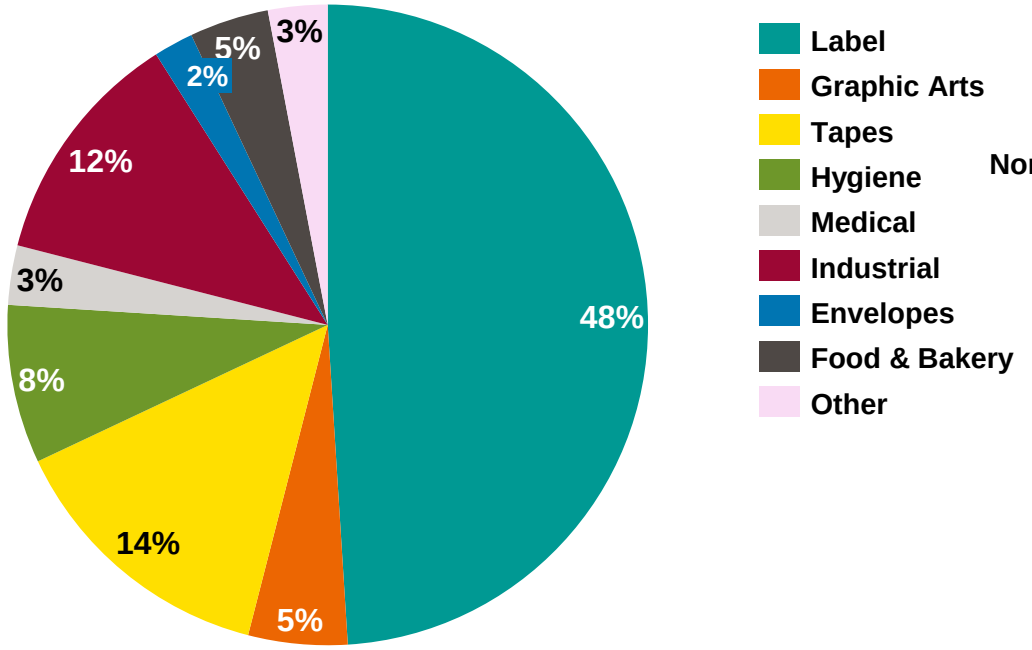
TEGO® RC Silicones
Global Release Liner Market – Applications and Regions (2022)

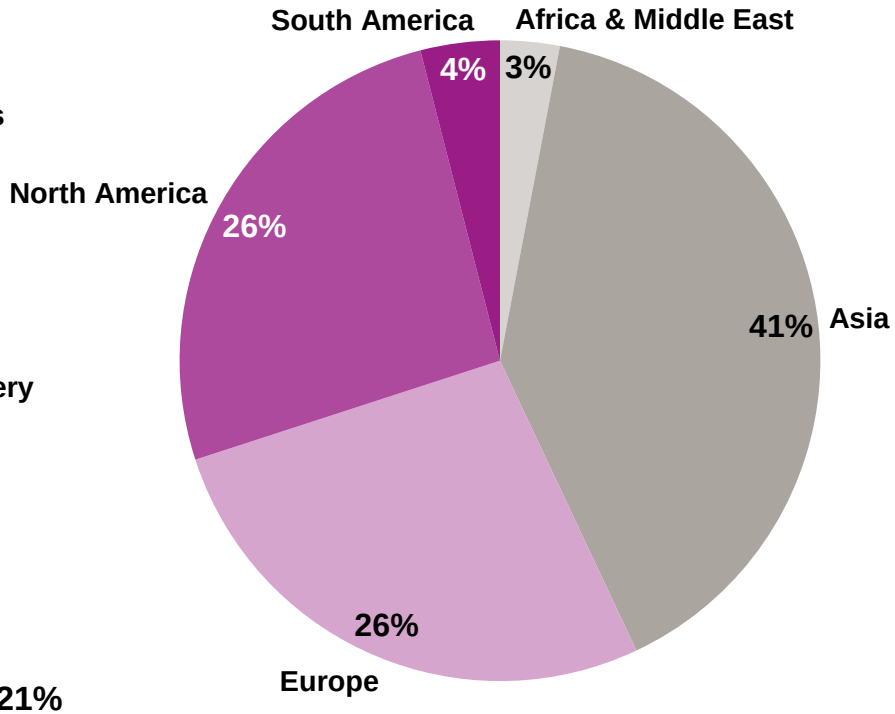
Global release liner market by segment in 2022 (paper + film)
60.486 billion m² - 60 486 tons of silicone @ 1g/m²



Source: AWA Assoc. BV

Share Filmic Liners: 21%

Global release liner market in 2022 by global distribution



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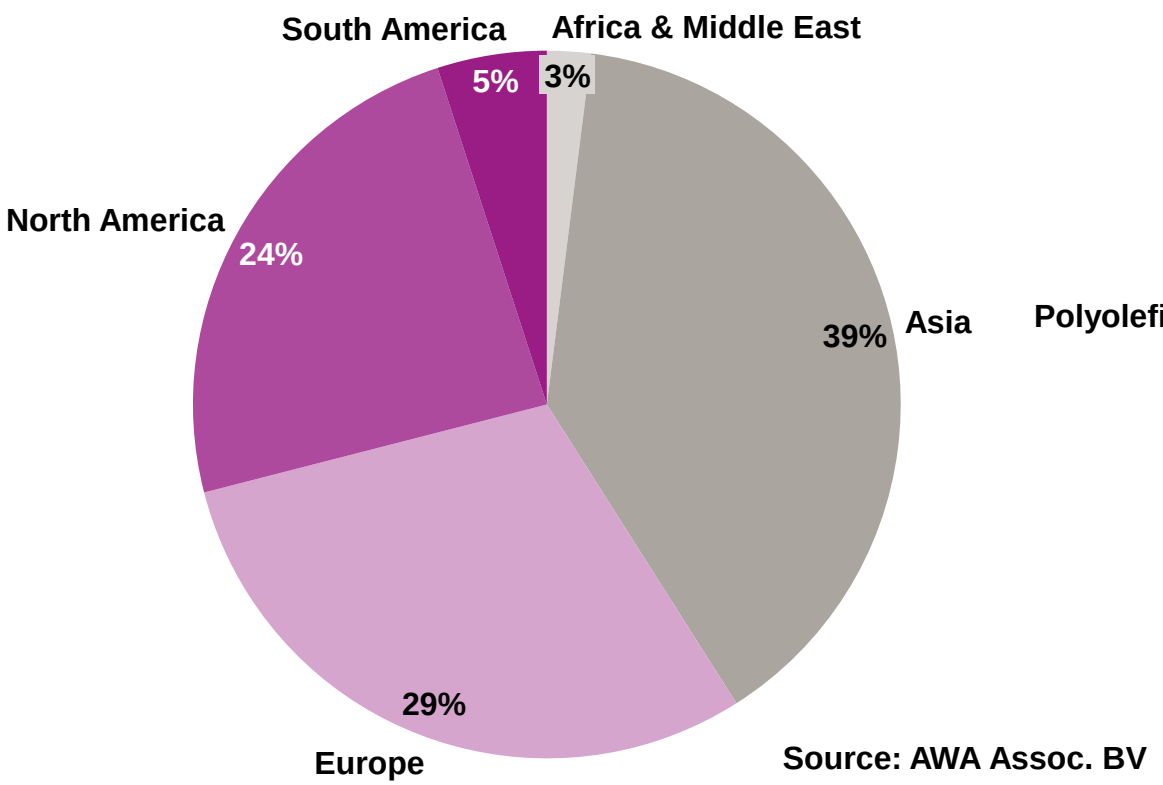
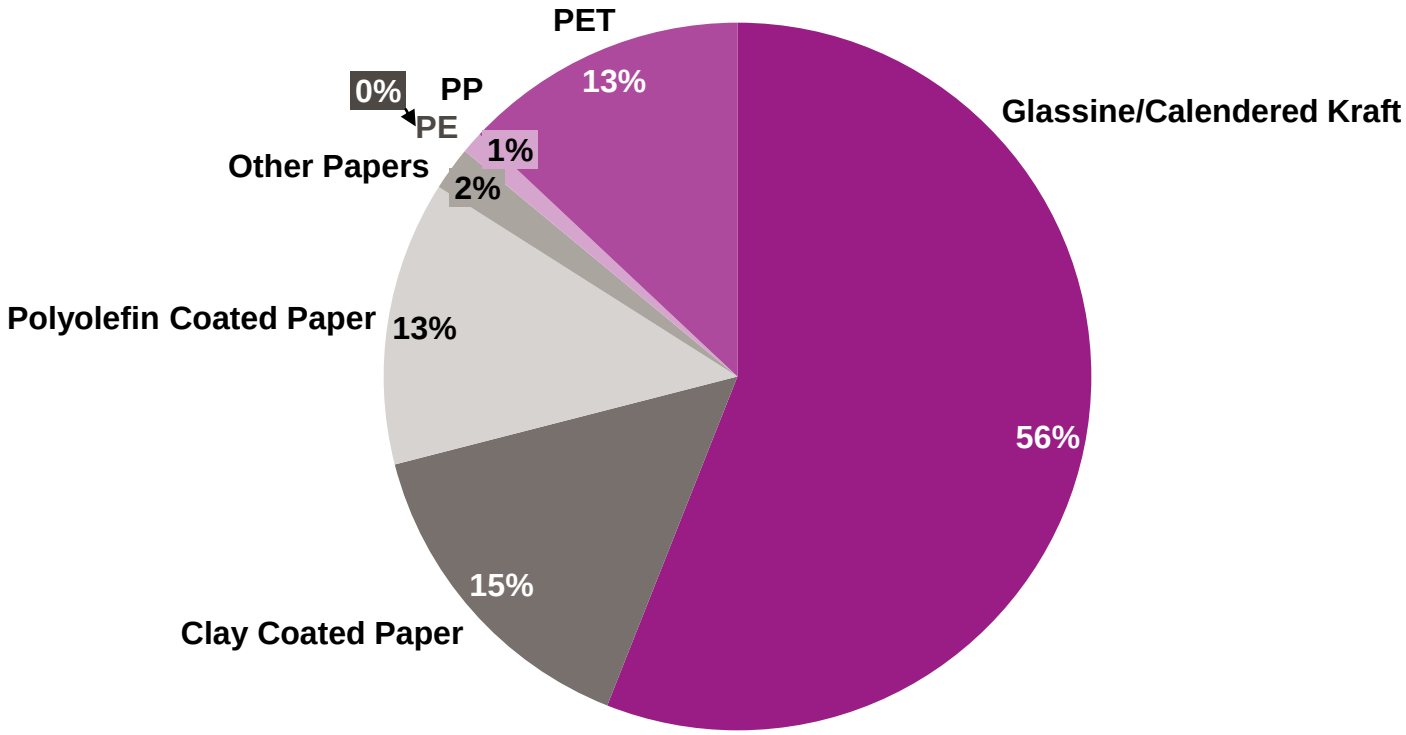
TEGO® RC Silicones
Global Release Liner Market For Labels – Regional Split

Global release liner : label application per region
29.267 billion m²



Source: AWA Assoc. BV

Label application by substrate



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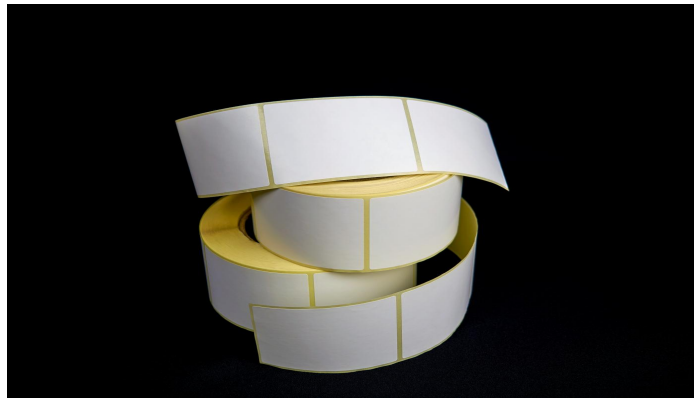
TEGO® RC Silicones
Market Applications

Labels



Linerless

Hygiene

Industrial

Tapes

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TEGO® RC Silicones – Why use UV silicones?

UV Curing & Advantages	
Easy Handling and Fast Curing	▪ Robust free radical curing reaction allows wide choice of possible substrates ▪ High production speeds ▪ Inline adhesive application possible ▪ Long pot life of mixed silicone, no gelation on coater ▪ Easy to handle & Store
Compact UV Equipment	▪ Common standard inerted UV chambers on coating lines, easy to retrofit on existing machines. • Smaller curing equipment for UV • For wide web and narrow web coating
Global Service and support	• Excellent technical face-to-face service with a global reach. Technical service teams and test facilities located in Europe, America and Asia.

Sustainable, Environmentally Friendly Solvent-Free Coatings	
Environmentally Friendly	▪ 100 % solvent free ▪ Minimal content of volatile organic compounds (VOCs) ▪ No heavy metals (platinum, tin) ▪ No need for solvent or water evaporation ▪ FDA approval for food contact (free radicals) ▪ Low energy consumption
Curing at Ambient Temperatures	▪ Lower Energy Consumption ▪ No dryer heating times, quick start of UV curing unit ▪ No film shrinkage ▪ Maintain-paper strengths, no paper curl and need for remoistering

TEGO® RC Silicones – Pilot lines
Global player with a presence in local markets

Evonik Technical Service Centers
Coating trials / Test lab

Richmond, VA USA

UV Pilot coater:
- Silicone coating 3 roll offset gravure coater
- Substrate on 3” core
- UV drying
- Web width 610 mm
- Line speed: 25-250 m/min

UV Lab coater:
- 5-Roll Silicone coater
- Web width 6 inch (152 mm)
- Line speed: max 50 m/min
- UV drying

Essen, Germany

UV Pilot line:
- 5-Roll Silicone coater
- in-line adhesive coating (dispersion or hot melt)
- Web width 520 mm
- Substrate on 3” core
- Line speed: 20-100 m/min
- UV arc and LED drying

UV Lab coater:
- 5-Roll Silicone coater
- Web width 150 mm
- Line speed: max 50 m/min
- UV arc and LED drying

Shanghai, China

UV Pilot coater
- Silicone gravure coating line
- Web width 336 mm
- Substrate on 3” core
- Line speed: max. 150 m/min
- UV arc drying

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TEGO® RC Silicones – UV-LED curing systems – RC Technicum in Essen

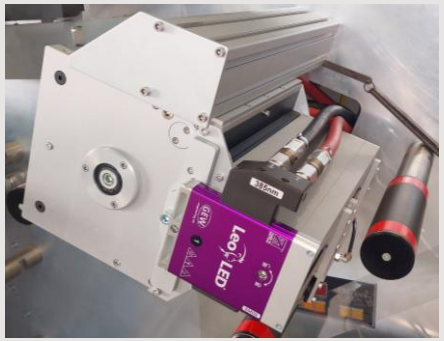
Global player with a presence in local markets

Evonik Technical Service Centers
Coating trials / Test lab

Essen, Germany **UV Lab coater:**

- 5-Roll Silicone coater
- Web width 150 mm
- Substrate on 3” core
- Line speed: max 50 m/min
- Inerted UV arc lamp 120 W/cm by IST
- Inerted UV-LED unit LeoLED by GEW on chill roller
  Peak Irradiance 30 Watt/cm^2 @ 385 nm

UV-arc system



UV-LED system

Essen, Germany **UV Pilot line:**

- 5-Roll Silicone coater
- in-line adhesive coating (dispersion or hot melt)
- Web width 520 mm
- Substrate on 3” or 6 “ core
- Line Speed Line speed: 20-100 m/min
- Inerted UV arc 200 Watt/cm by IST
- Inerted UV-LED cassette Modulux by IST; 20 Watt/cm^2 @ 385 nm

UV-arc system

UV-LED module

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TEGO® RC Silicones
Portfolio Overview

Release Coatings
TEGO® RC UV Free Radicals and TEGO® RC UV Cationics

- TEGO® RC Silicones are functional silicone polymers. The functional groups are firmly linked to the silicone backbone.
- Our products are 100% polymeric materials and contain no solvents. UV curing requires the addition of a Photoinitiator (PI).
- There are two UV curable silicone release systems on the market. Both are solventless and produce release coatings without the use of heat but differ in their underlying chemistry.
- Evonik offers both free radical and cationic curing silicones.
- The first is based on silicone acrylate and cures via a free radical mechanism, whilst the other release system uses epoxy silicones and cures in the presence of a cationic photo-catalyst.

TEGO® RC Silicones
Product Overview - Radical curing UV silicones

Base Components
We offer several components that allow you to adapt the silicone formulation to your specific needs. Base components need to be blended in your production plant.*

TEGO® RC 902	▪ Easy release	**TEGO® RC 711**	▪ Anchorage component and tight release
TEGO® RC 922	▪ Premium release	**TEGO® RC 722**	▪ Anchorage component and tight release
TEGO® RC 715	▪ Controlled release	**TEGO® RC 730**	▪ Anchorage component for Linerless label
TEGO® RC 800	▪ Controlled to tight release	**TEGO® Photoinitiator A18**	▪ Photoinitiator for all single component formulations

**A typical formulation includes a release component, an anchorage component and Photoinitiator A18 (2%)*

TEGO® RC Silicones
Product overview - Radical curing UV silicones

One Component Systems – Ready to use blends
We offer a selection of products where the release and anchorage component as well as the Photoinitiator A18 are already contained. Our one component systems facilitate handling during your production as they are used without the need for blending.

TEGO® RC 702	▪ Easy release formulation
TEGO® RC 1200	▪ Reduced penetration easy release silicone for open papers
TEGO® RC 1772	▪ Low CoF additive to standard blends and matte surface
TEGO® RC 1904	▪ Premium release formulation for high-speed release applications (e.g. auto-apply labels)
TEGO® RC 1908	▪ Premium release formulation for low-speed release applications (e.g. electronics)
TEGO® RC 1930	▪ **New:** Low release blend for thermal linerless labels
TEGO® RC 2000 LCF	▪ **New:** Low release blend made of recycled Silicone feedstock, curable **by UV arc or UV-LED lamps**

TEGO® RC Silicones
Product overview - Cationic Curing UV Silicones

Cationic Curing Components
We offer two components that allow you to adapt the silicone formulation to your specific needs. Base components need to be blended in your production plant.*

TEGO® RC 1442	▪ Easy release silicone
TEGO® RC 1412	▪ Tight release silicone
TEGO® Photocompound 1467	▪ Cationic photocatalyst

**A typical formulation includes a release component and Photocompound 1467 (2%)*

Applications

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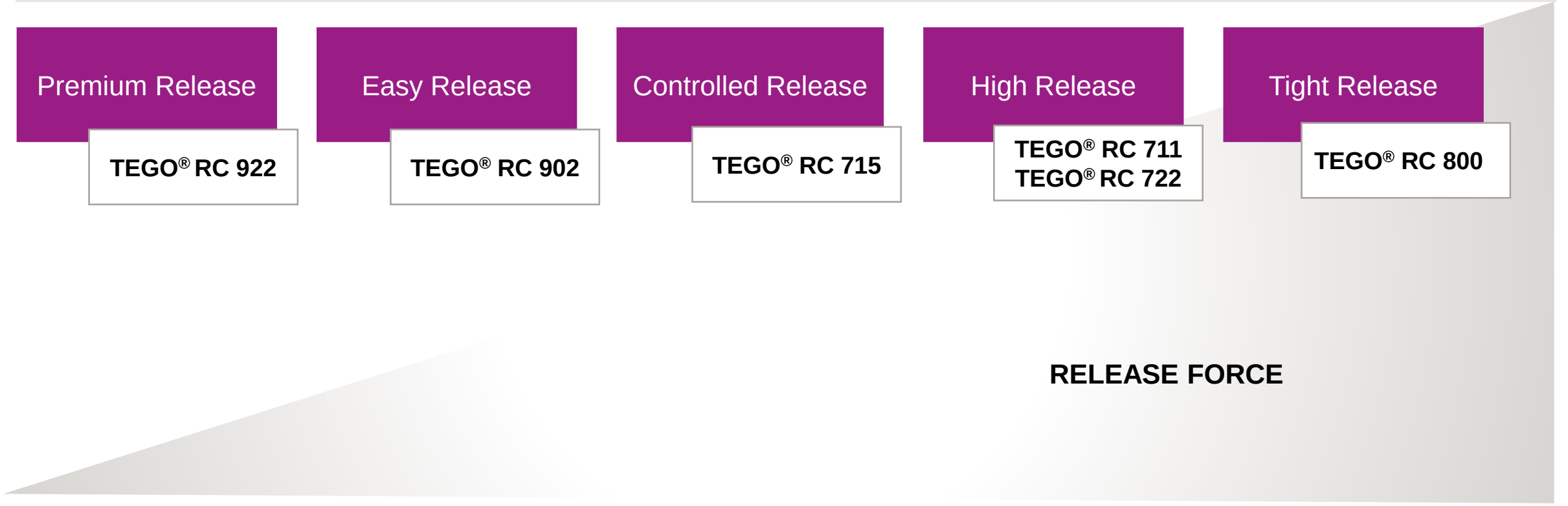
TEGO® RC Silicones
Free radical single components in range of release

Addition of 30% TEGO® RC 711 or RC 722 blended with these products is recommended for proper anchorage.



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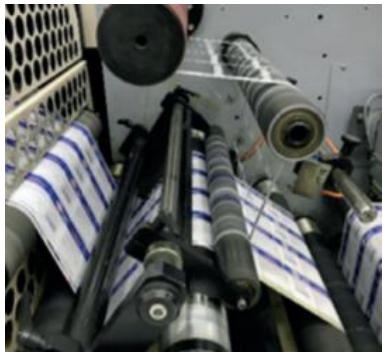
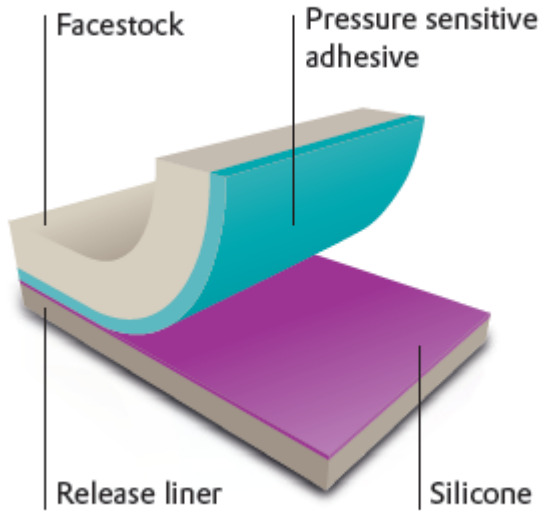
Label Applications

TEGO® RC for Self Adhesive Labels

	Applications
Substrate	Paper - glassine, clay coated, PE coated papers …. Plastic - PET, PE, PP, PVC, biobased films
Laminate	Pre-manufactured laminate In-house siliconizing e.g. narrow web paper/film substrate
Dispensing	Hand applied, automated high speed
Adhesive	Compatible with a broad range of adhesive types as hot melts, acrylic adhesives



Performance
Release range covers premium/controlled/tight
No loss of tack and adhesion of the label
Reliable matrix stripping
Stable release and high subsequent adhesion



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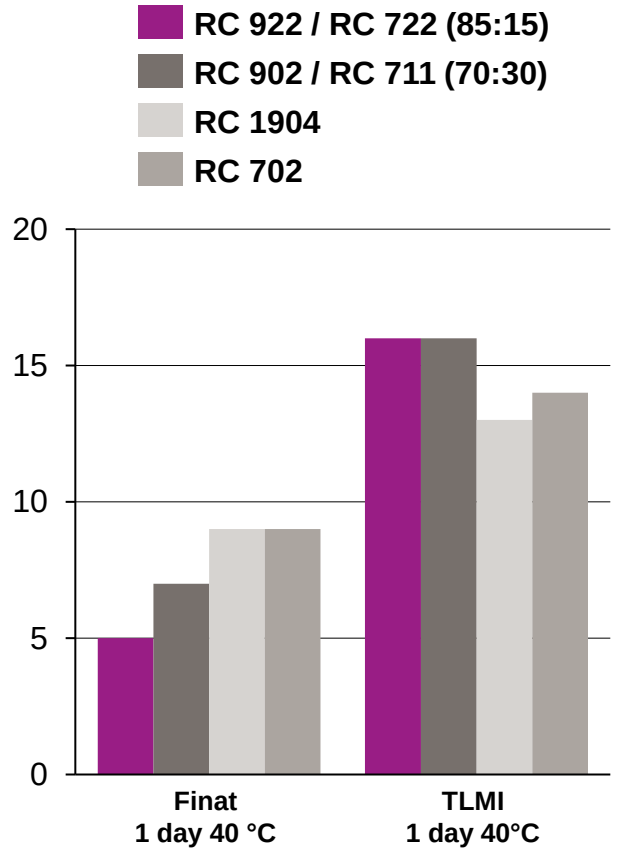
TEGO® RC for Self Adhesive Labels

Product Formulations	Release Performance
TEGO® RC 902/711	Standard blend for easy release
TEGO® RC 922/722	Blend for premium release with excellent anchorage

One Component Systems	Release Performance
TEGO® RC 702	Easy release for wide range of applications
TEGO® RC 1904	Premium release for high speed peel off applications



Release tesa 7475 in [cN/25 mm]
(coat weight 1.0 g/m² on BOPP film)

TEGO® RC Silicones Customer Presentation | December 2022

Linerless Applications

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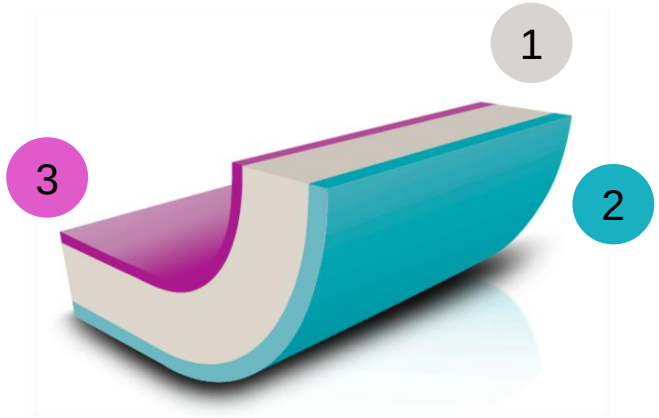
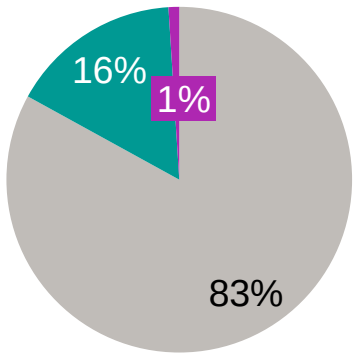
TEGO® RC for Linerless Applications



1) Label-face
2) Adhesive
3) Silicone



Paper weight only for DTL

Weight: 80-100 g/m²*

- **Linerless labels** consist of **3 layers**: silicone based release coating, label-face and an adhesive
- The label is **wound directly into a roll**, like adhesive tape
- A **silicone coating** ensures that the **windings separate cleanly and quickly** before dispensing the individual label

Key Benefits	
Performance	• Flexible / Customizable label length • Premium surface feel and look • Improved surface protection against scratch, water, oil, and abrasion • High accurate scan read rates
Logistics	• Reduction of logistic footprint • Extended reel duration: 50% more labels on reel • Less downtime in label dispensing
Sustainability	• Linerless brings significant sustainability benefits – up to 40% less material usage. • Carbon footprint of the Linerless label technology is 40% lower than standard labels.

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TEGO® RC for Linerless Applications

Linerless Applications	
VIP Labels (Variable information printing)	The main applications are weight scaling, transportation, warehousing/logistics, fast food and tape branding.
Primary Product Labelling	The main applications are Wrap/Sleeve food and beverage packaging, postal services and others.

Product Formulations	Release Performance
TEGO® RC 730 / RC 902 / A18 (60:40:2)	Easy release blend on thermal papers
TEGO® RC 1930	1-Component easy release for thermal papers
TEGO® RC 902 / RC 711 / A 18 (70:30:2)	General easy release for films and papers
TEGO® RC 702	1-Component easy release for films and papers

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Hygiene Applications

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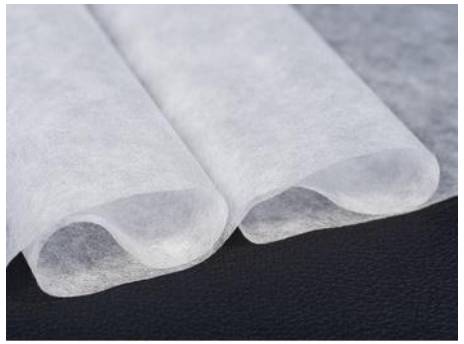
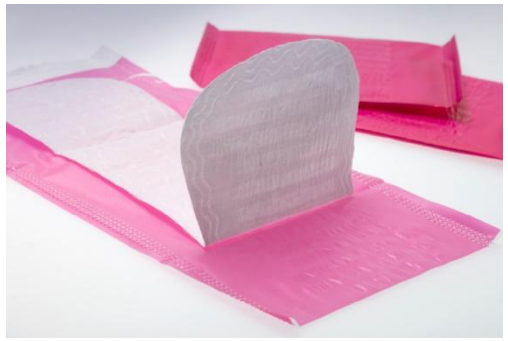
Hygiene Applications

Substrates used

- PP Film
- PE Film
- Glassine Paper
- Non-woven





Adhesives used

- Hot Melts

TEGO RC Silicones for Hygiene Application

Diaper tapes

- Broad range of release values
- All substrates possible
- Excellent anchorage
- Suitable for open / porous surfaces, e.g. Non-woven
- Compliance with regulatory standards

Feminine Care Products

- Release values adjustable from easy to controlled release
- Low coat weights possible
- Allows for high speed siliconizing
- Excellent anchorage, no silicone transfer
- Compliance with regulatory standards

TEGO® RC Silicones for Hygiene Applications

Product Formulations	Release Performance	Application
TEGO® RC 902 / RC 711 or RC 722	Standard blend for easy release	Diaper tapes Feminine care
TEGO® RC 715/ RC 711 or RC 722	Blend for controlled release	Diaper tapes Feminine care
TEGO® RC 800 / RC 715 / RC 722	Blend for controlled to tight release with excellent anchorage	Diaper tapes

One Component Systems	Release Performance	Application
TEGO® RC 1200	One component easy release product	Diaper tapes

Industrial Applications

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TEGO® RC for Industrial Applications

Applications	Key Benefits
Composites and Construction	• Broad range of release values • For differential release • Suitable on all plastic films • Stable release at higher temperatures • No silicone transfer
Electronics	• Super premium release for low peel speeds • Good curing performance • Stable release over time • Good anchorage on many substrates • Good coatability due to low viscosity

TEGO® RC for Industrial Applications

Product Formulations	Release Performance
TEGO® RC 922 / RC 722	Blend for premium release
TEGO® RC 902 / RC 711 or RC 722	Standard blend for easy release
TEGO® RC 715 / RC 711 or RC 722	Blend for controlled release
TEGO® RC 800 / RC 715 / RC 722	Blend for controlled to tight release with excellent anchorage

1-Component blends	Release Performance
TEGO® RC 702	One component easy release product
TEGO® RC 1904	One component easy release product
TEGO® RC 1908	One component premium release product

Technical Guide

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Technical Overview

TEGO® RC Silicones:
functional silicone polymers

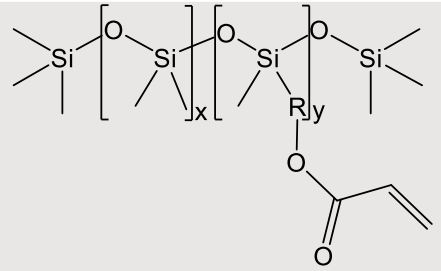
The functional groups are firmly linked to the silicone backbone.

The products are 100% polymeric materials and contain no solvents.

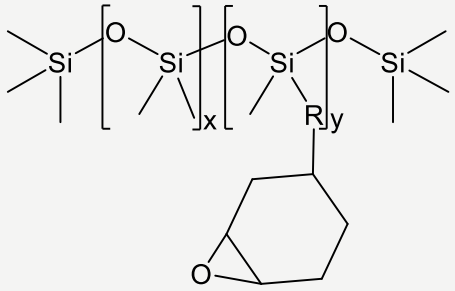
The products are cured by UV light, no heat needed.

Evonik offers two UV curable silicone release systems with a different underlying chemistry.

Silicone acrylates cure in the presence of a free radical photoinitiator



Epoxy silicones cure in the presence of a cationic photo-catalyst



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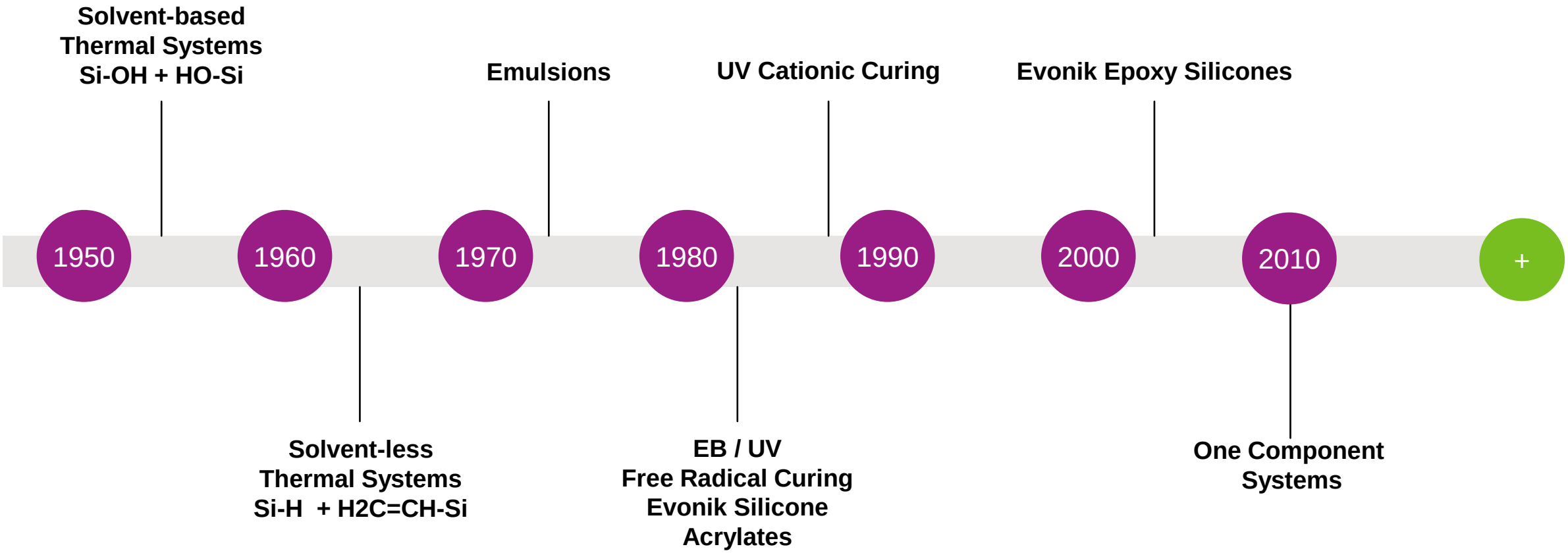
TEGO® RC Silicones History

Pioneer and leading supplier for UV Silicones since 1985



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Processing

TEGO® RC Silicones: coating and laminating

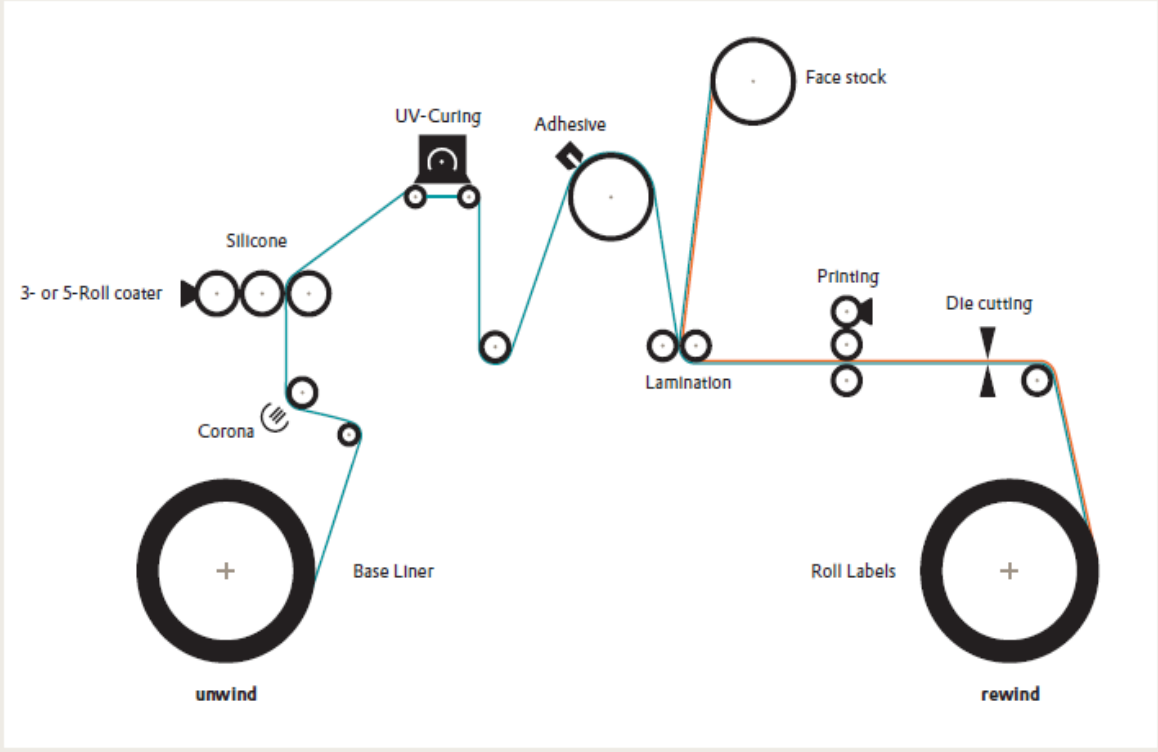
1) In-line corona treatment prior siliconization recommended for best anchorage.

2) 3- or 5-roll coater for silicone to obtain best coverage of substrates.

3) UV curing station with Nitrogen inerting (free radical)

Optional in-line label converting:
- 4) adhesive coating and 5) lamination
- 6) printing, 7) die-cutting, matrix stripping & slitting

PICTURE 5
Schematic sequence of label production applying in-line silicone and adhesive coating



Regulatory

Food Contact Status

- FDA Food Contact Notification
  FCN 041 for RC 711, RC 715, RC 726, PC 750
  FCN 369 for RC 902 (in combination with A18)

- FDA Regulations 21 C.F.R. 175.105 ("Adhesives") and
  C.F.R. 175.125 ("Pressure sensitive adhesives")
  for release coatings up to 0.9 g/m² for film and up to 1.2 g/m² for paper based on
  RC 706, RC 711, RC 715, RC 726 (FCN 41) and RC 902 (FCN 369) with
  2 % A18

- Certificate of conformity by ISEGA
  for § 31 Food, Consumer Goods and Feedstuffs Code (LFGB)
  for free radical curing silicones

- FDA compliance for release coatings up to 1.93 g/m^2 total coat weight under
  conditions of use C, D, and E for RC 730

Conclusion

Evonik TEGO® RC, a pioneer for UV curable silicone technology

With over **thirty-five years**, Evonik has been an expert in UV curable silicone release systems for the **PSA** (pressure sensitive adhesive) market. RC Silicones from Evonik cover both **free radical curing silicone acrylates** and the **cationic curing epoxy silicones**.

Evonik TEGO® RC has continuously developed innovative solutions for the **tape**, **standard label**, **linerless label**, **hygiene** and **industrial market applications**.

TEGO® RC Silicones offer numerous benefits with **high performance**, **processing**, **quality**, **material compatibility**, **environmental** and **investment advantages**.

Through cooperation's with equipment manufacturers for converting and coating as well as material suppliers Evonik's TEGO® RC team strives for **continuous improvement of processes**, making us the partner of choice for in-house siliconizing.

TEGO® RC Silicones guarantee successful **in-line converting** of entire labels. The **patented UV radical technology** allows for instant cure meaning **no post cure**, **efficient operation** and **high quality**.

With our **global network** of experts and local test facilities serving and supporting you in your product developments.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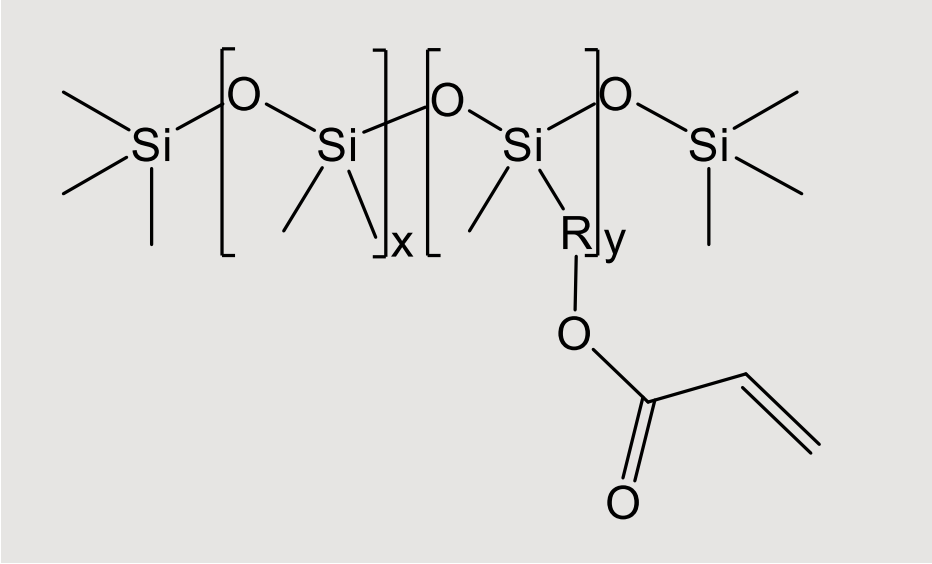
Chemical Background

TEGO® RC Silicones – Free radical UV curing Silicone Acrylates

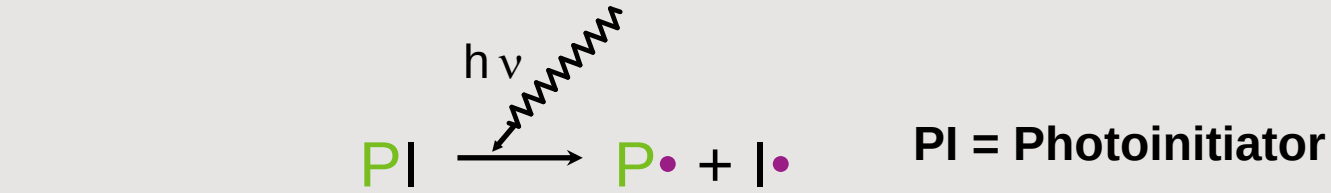
Example of a Silicone Acrylate

Advantages	
Fast and effective curing	▪ High local acrylate concentration ▪ Multiple curable centres
Stable and low release	▪ Hydrolytic stable SiC bonds



TEGO® RC Silicones – Free Radical Polymerisation of Silicone Acrylates

Initiation



PI = Photoinitiator

$$P\bullet + CH_2{=}CHCOO\text{-}R \rightarrow P\text{-}CH_2\text{-}CH\bullet COO\text{-}R$$

Propagation

$$P\text{-}CH_2\text{-}CHR\bullet + CH_2{=}CH(COO\text{-}R) \rightarrow P\text{-}CH_2\text{-}CHR\text{-}CH_2CH\bullet COOR$$

Termination

$$2\ P\text{-}CH_2\text{-}CH\bullet COO\text{-}R \rightarrow P\text{-}CH_2\text{-}(R)_x\text{-}CH_2\text{-}P$$

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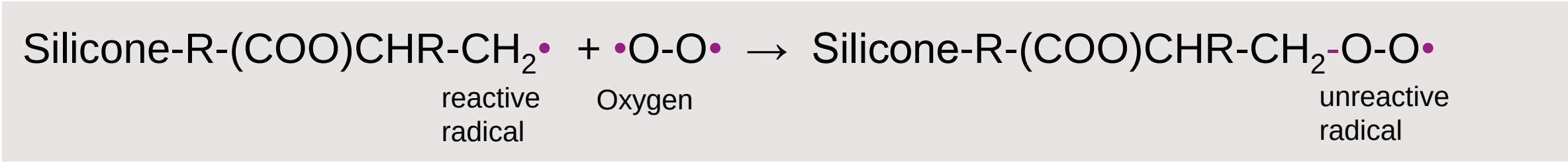
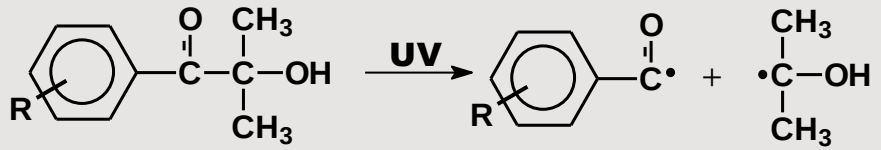
TEGO® RC Silicones – Free radical UV curing - Nitrogen inerting

Oxygen Inhibition – Silicone curing reaction may be incomplete by ambient air



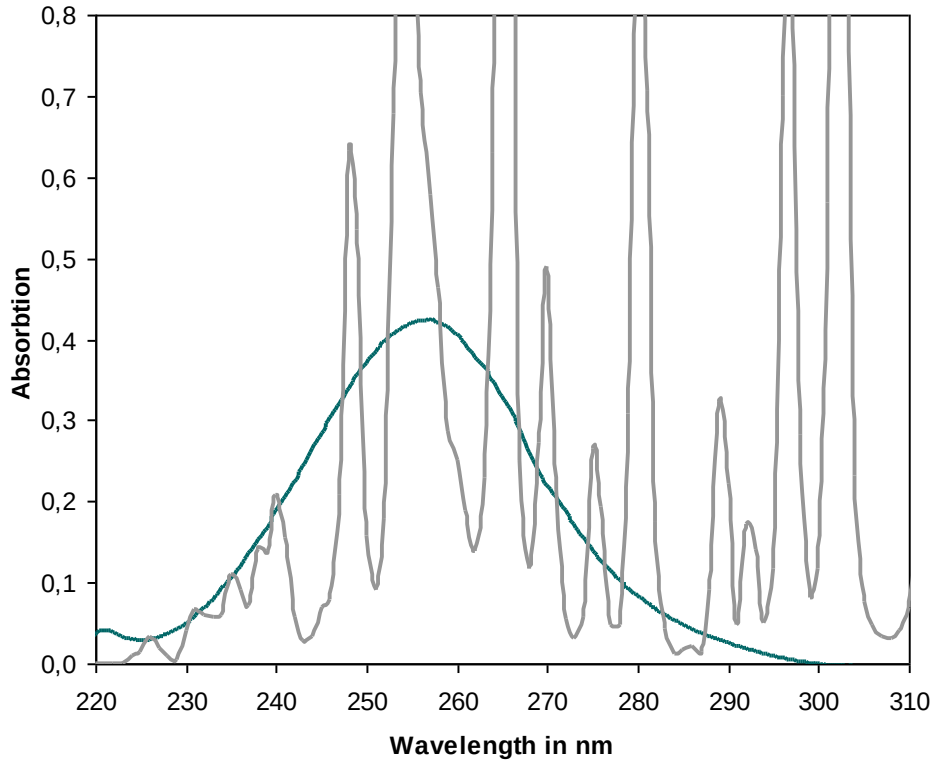
- Liquid Nitrogen preferred to feed UV inert chamber
  Liquid gas tank and evaporator can be rented from gas supplier
- Nitrogen Quality 4.6 or 5.0 (< 10 ppm O_2).
- Nitrogen costs less than 1 % of a label construction.

TEGO® RC Silicones – Free radical curing Photoinitiator A18



TEGO® Photoinitiator A18 is a proprietary grade type-1-photoinitiator with

- outstanding silicone solubility
- highest reactivity in free radical curing silicones
- no odour during UV curing, less VOCs,
  less equipment pollutions



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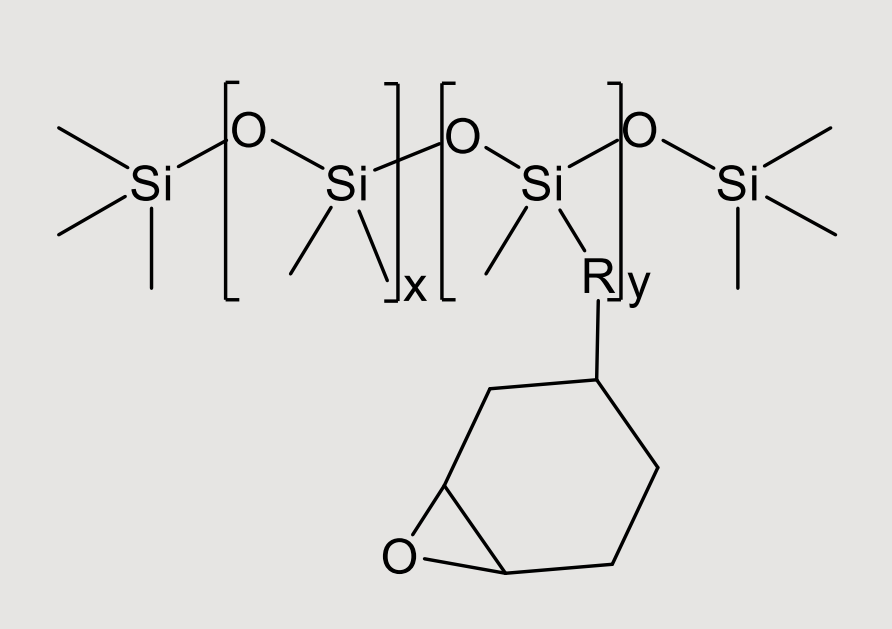
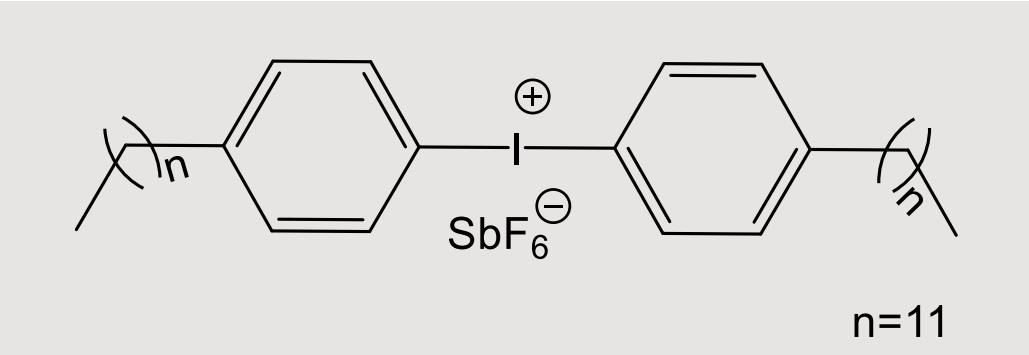
TEGO® RC Silicones – Cationic UV curing Epoxy Silicones

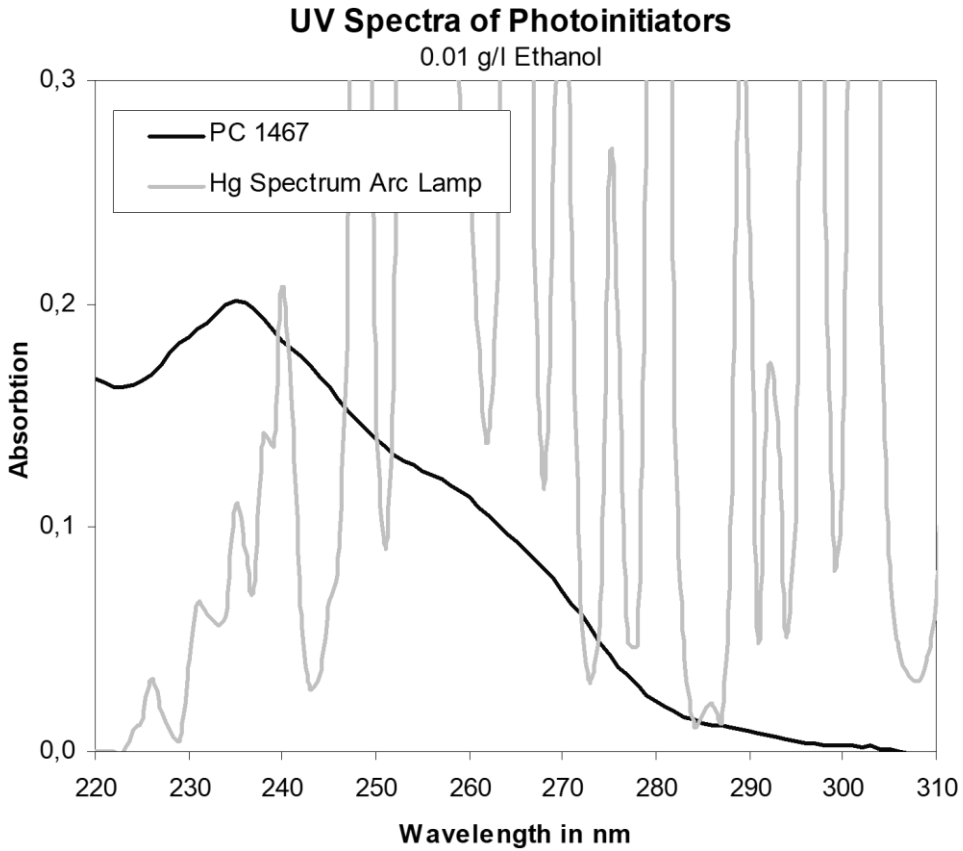
Easy Release Silicone TEGO® RC 1442

- Easy to handle and use
- Fast curing at 1 to 2 % addition of PC 1467
- Nitrogen inerting not required
- Sensitized silicone for very fast curing
- Stable and low release with most PSA´s
- Low extractables



TEGO® RC Silicones – Cationic UV curing Photocompound PC 1467





TEGO® PC 1467 offers high curing speeds and excellent compatibility with all cationic curing silicones of the TEGO® RC 1400 series.

- Good compatibility with non-polar cationic curing silicones
- Solvent free
- Fast curing with standard UV lamps
- No Nitrogen inerting needed
- Long shelf life
- No benzene emission

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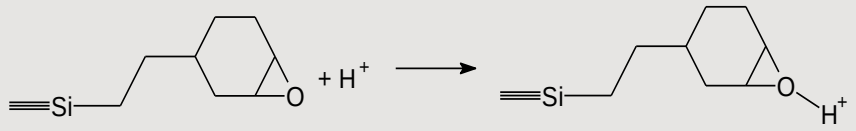
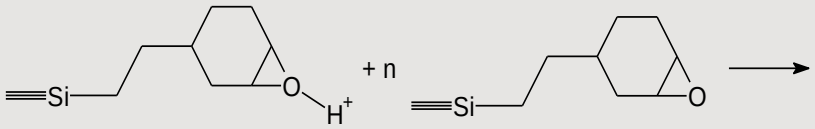
TEGO® RC Silicones – Cationic UV curing

Protonation

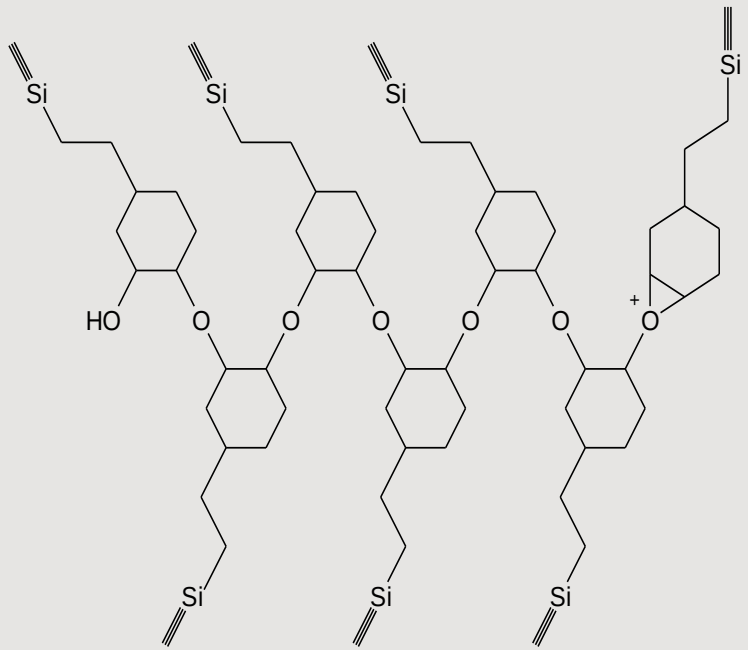


Polymerisation



not inhibited by oxygen

Network



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Additional Slides

TEGO® RC Silicones – Silicone Types

UV Curing: Cationic or Radical?

	Free Radical Curing	Cationic Curing
Nitrogen Inerting	Necessary	Not necessary
Photoinitiator Poisoning	None	Yes
Substrate	No restrictions	Restrictions
Post Curing	None	Yes
Moisture Inhibition	None	Yes
Bath Life	Several months	Days up to weeks

TEGO® RC Silicones – Why use UV silicones?

TEGO® RC Silicones cure under UV light with low heat impact to the substrate.

- Use of heat-sensitive materials are possible:
  - thin plastic films like PE, PP, PET, PVC - no shrinkage after curing
  - thermal papers for Linerless labels – no coloration after curing
- Paper substrates stay absolutely flat after UV curing
  - no shrinkage, no curl of papers like Glassine, CCK, PEK
  - no re-moisturing needed
- Cost reduction possible
  - by down gauging films and papers, fast production speeds
- Environmentally friendly production
  - low energy consuming, no solvents involved