TEGO® RC Silicones

TEGO® RC Silicones – Introduction
November 2018
TEGO® RC Silicones – Introduction

Construction of a Label Laminate

Label
Pressure Sensitive Adhesive
Substrate
Silicone
TEGO® RC Silicones – Introduction

Global market

World market release liner: 
(paper + film in 2017)

50.0 billion m²
~ 50 000 tons of silicone @ 1g/m²

Share Filmic Liners 19 %

Source: AWA Assoc. BV
TEGO® RC Silicones – Introduction

Labelstock

- standard label products, clear-on-clear labels, thermal labels, linerless labels

Building & Insulation

- membranes, foams,
- floor covering,
- sound deadening,
- bitumen

Tapes

- industry, electronics, security, insulation, carpet, envelopes, office

Personal Hygiene

- diaper tapes, sanitary napkins

Others

- thermal transfer printing, over laminating, protective films, process liners, ceramic capacitor
**TEGO® RC Silicones – Introduction**

**Global market**

**World market release liner:**
(paper + film in 2017)  
50.0 billion m²  
~ 50 000 tons of silicone @ 1g/m²

*Source: AWA Assoc. BV*

**Applications**

*Source: AWA Assoc. BV*
When thermal silicones have to give up ...

TEGO® RC Silicones will provide a solution for you!

- Use of heat-sensitive films
  - PE, PP, PET, PVC
- Absolute paper lay flat
  - coated craft paper like CCK, PEK
- Cost reduction
  - down gauging films and papers
- Environmentally friendly production
  - low energy consuming, no solvents
TEGO® RC Silicones – Introduction

TEGO® RC Products make it possible to reduce your waste:

- Linerless Labels
- Linerless Thermal Print
- Curing on Recycled Substrates
- 100 % Recyclable Liners
- Bio-Films such as PLA
- Thin BoPP Liners

- Partnerships with Linerless Innovators:
  - ETI Converting Equipment
  - Ravenwood Packaging
  - Catch Point Labels

No liner – No waste
Linerless labels with TEGO® RC Silicones
Easy to Handle Machinery

- Compact construction, easy retrofitting
- Approx. 1.3 m in web direction, less floor space
- Low equipment investment
- Extremely short start-up times (< 5 min.)
- Less silicone waste, less rejects of substrate
TEGO® RC Silicones – Introduction

Our technology support

- Introduce you to release liner basics and testing
- Support in choosing the best suitable UV equipment
- Assistance during commissioning and ramp-up
- Optimizing coater settings and UV curing

- Partnership to develop new applications
  - Development of suitable silicone formulation
  - Use of our pilot lines to test different substrate types
  - Examination of silicone-adhesive interaction
  - Recommendations for improved adhesive formulation
  - Global Tech. Service network for local support
  - Confidentiality
TEGO® RC Silicones – Silicone Types

Evonik: Pioneer and leading supplier for UV Silicones since 1985

- Solvent-less Thermal Systems
  - Si-H + H₂C=CH-Si

- Silicone Acrylates
  - EB / UV
  - Free Radical Curing
  - 4th Generation
  - True 1C Systems

- Solvent-based Thermal Systems
  - Si-OH + HO-Si

- Emulsions
  - UV Cationic Curing


TEGO® 1400er Series

Epoxy Silicones
### TEGO® RC Silicones – Silicone Types

#### UV Curing: Cationic or Radical?

<table>
<thead>
<tr>
<th></th>
<th>Free Radical Curing</th>
<th>Cationic Curing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen Inerting</td>
<td>Necessary</td>
<td>Not necessary</td>
</tr>
<tr>
<td>Photoinitiator Poisoning</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Substrate</td>
<td>No restrictions</td>
<td>Restrictions</td>
</tr>
<tr>
<td>Post Curing</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Moisture Inhibition</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Bath Life</td>
<td>Serval months</td>
<td>Days up to weeks</td>
</tr>
</tbody>
</table>
## TEGO® RC Silicones – Silicone Types

### Cure Speed with one 120 W/cm UV Lamp

<table>
<thead>
<tr>
<th>Formulations containing</th>
<th>Cure Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC 702, RC 922, RC 902, RC 800, RC 1002</td>
<td>up to 200 m/min.</td>
</tr>
<tr>
<td>RC 715, RC 1772</td>
<td>up to 300 m/min.</td>
</tr>
<tr>
<td>RC 711, RC 722 pure</td>
<td>up to 400 m/min.</td>
</tr>
</tbody>
</table>

**Free radical curing**

RC Silicone with 2 % A18

**Cationic Curing**

RC Silicone with 2 % PC 1467

Substrate and humidity influence cure speed between 50 and 300 m/min.
TEGO® RC Silicones – Silicone Types

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 A12)

• 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

Please contact us for more details.
High in-line corona treatment is important

Primary: Oxidation and ionization of the surface
= good chemical anchorage

Secondary: Increase of the surface tension
= good wetting

Silicone Anchorage to the substrate

- Addition of min. 30 % RC 711 or 15 – 30 % RC 722 (free radical curing)
- Special anchorage additive
- In-line corona treatment
**TEGO® RC Silicones – Silicone Types**

### Release Level Characterisation

<table>
<thead>
<tr>
<th>Type</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>premium release</strong></td>
<td>&lt; 10 cN/inch</td>
</tr>
<tr>
<td><strong>easy release</strong></td>
<td>10 - 30 cN/inch</td>
</tr>
<tr>
<td><strong>controlled release</strong></td>
<td>30 - 200 cN/inch</td>
</tr>
<tr>
<td><strong>high release</strong></td>
<td>200 - 500 cN/inch</td>
</tr>
<tr>
<td><strong>tight release</strong></td>
<td>&gt; 500 cN/inch</td>
</tr>
</tbody>
</table>
### TEGO® RC Silicones – Silicone Acrylates

#### Free Radical Curing silicones

<table>
<thead>
<tr>
<th>TEGO® RC 922</th>
<th>premium release</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEGO® RC 902</td>
<td>easy to controlled release</td>
</tr>
<tr>
<td>TEGO® RC 715</td>
<td>controlled release</td>
</tr>
<tr>
<td>TEGO® RC 711</td>
<td>tight release</td>
</tr>
<tr>
<td>TEGO® RC 722</td>
<td>controlled to tight release for</td>
</tr>
<tr>
<td></td>
<td>“differential“ release values</td>
</tr>
<tr>
<td>TEGO® RC 800</td>
<td></td>
</tr>
</tbody>
</table>

Addition of 30 % TEGO® RC 711 for proper anchorage (or 15 - 30 % TEGO® RC 722)
TEGO® RC Silicons – Silicone Acrylates

Easy to use one component systems

- **TEGO® RC 702**
  - easy release

- **TEGO® RC 1002**
  - easy release with RPS effect

- Reduced penetration silicone (RPS) for open papers

- **TEGO® RC 1772**
  - matte surface and low CoF additive

- For special matte appearance of silicone surface
- Reduced Coefficient of Friction (CoF)
Advantages on Paper Substrates

- No shrinkage of paper
- No re-moisturization
- Excellent lay-flat behaviour
- No loss of paper strengths with UV
- No photoinitiator poisoning

- All paper types possible
- Growing interest in alternative inexpensive papers
TEGO® RC Silicones – Silicone Acrylates

Advantages on Plastic Film Substrates

- Lower film gauges
- Siliconizing of thermo-sensitive substrates possible
- No limitations with choice of filmic substrates

- Film siliconising shows strongest growth
TEGO® RC Silicones – Silicone Acrylates

Example of a Silicone Acrylate

- Multiple curable centres
- Fast and effective curing
- Hydrolytic stable SiC bonds
- High local acrylate concentration
- Easy release properties
- Good aging properties
Propagation

\[ P - \cdot + C = C \rightarrow P - C - C \cdot \]

\[ P - C - C \cdot + C = C \rightarrow P - C - C - C - C \cdot \]

Termination

\[ P - C - C \cdot + . C - C - P \rightarrow P - C - C - C - C - P \]
TEGO® RC Silicones – Silicone Acrylates

TEGO® Photoinitiator A18

\[
\text{HMPP} \xrightarrow{\text{UV}} \text{RC Silicones} \quad \text{–} \quad \text{Silicone Acrylates}
\]

TEGO® A18 are modified version of 2-Hydroxy-2-methyl-phenyl-1-propanone (HMPP) with

- improved silicone solubility
- highest reactivity in free radical curing silicones
- no odour during UV curing, less VOC
Standard UV lamps are good for TEGO® Photoinitiator A18
Nitrogen from a rental liquid gas tank and evaporator is cost effective available.

Quality 4.6 or 5.0 (< 10 ppm O₂).

Nitrogen costs less than 1 % of a label stock.
TEGO® RC Silicones – Silicone Acrylates

Barrier Nozzle
laminar flow for the replacement of the boundary layer

Gap $s = 0.8 \text{ mm}$

$a \leq 3s$
Advantages of Free Radical UV Curing

- No post-curing perfect for in-line coating
- Rapid curing one 120 W/cm lamp for 200 m/min.
- Cure speed independent of substrate and silicone coat weight
- Less misting even at higher line speeds
Advantages of Free Radical UV Curing

- Very long pot life
- Easy cleaning procedure
- No gelation on coater
- Short runs with little waste of substrate and silicone
- Very consistent release values
- Wide range of release values

Production start up with RC 902 / RC 711 / 70 : 30
TEGO® RC Silicones – Silicone Acrylates

Long Time Release Stability RC 902 / RC 711 / 70 : 30

- HotMelt, permanent
- Waterbased acrylic, permanent
- Waterbased acrylic, removable

![Graph showing the comparison of long-time release stability at 40°C for different adhesives.](image-url)
TEGO® RC Silicones – Silicone Acrylates

Possibilities for New Developments

Silicone coatings with special properties by adding:

- Aluminium & Foils
- Foams
- Non-Woven & Textiles
- Office papers
- Printed Surfaces
- PVC
- Recycled Materials
- Renewable Films
- Thermal Papers
- Thinnest Films

- Matting agents
- Colours / pigments / dyes
- Anchorage additives
- Diluents
TEGO® RC Silicones – Epoxy Silicones

Range of products cationic curing silicones

<table>
<thead>
<tr>
<th>TEGO® RC 1401</th>
<th>for premium release applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEGO® RC 1403</td>
<td>for easy release applications</td>
</tr>
<tr>
<td>TEGO® RC 1412</td>
<td>for tight release</td>
</tr>
<tr>
<td>TEGO® PC 1467</td>
<td>photo catalyst</td>
</tr>
</tbody>
</table>

**Note:** All silicones contain ITX, TEGO® RC 1403 is not available in the USA and Canada.
Easy Release Silicone TEGO® RC 1403 and RC 1401

- Easy to handle and use
- Fast curing at 1 to 2 % addition of PC 1467
- Inerting not required
- Sensitized silicone for very fast curing
- Stable and low release with most PSA´s
- Low extractables
TEGO® RC Silicones – Epoxy Silicones

Photocatalysts for cationic curing silicones

Evonik TEGO® PC 1467
Momentive

BlueStar

CH$_3$\(\text{CH}_2\)$_n$\(\text{CH}_3\)

\(\text{CH}_3\)\(\text{CH}_2\)$_n$\(\text{CH}_3\)

SbF$_6$\(^-\)

n = 11
UV Spectra of Photoinitiators
0.01 g/l Ethanol

- PC 1467
- Hg Spectrum Arc Lamp

Absorption vs. Wavelength in nm
TEGO® RC Silicones – Epoxy Silicones

Protonation

Polymerisation

not inhibited by oxygen

Network
TEGO® RC Silicones – Epoxy Silicones

How to Enhance the Degree of Cure

- No additives in filmic substrates such as slip additives, colours, stabilizers
- No alkaline or coated papers

- Standard concentration of photocatalyst PC 1467 is 1 – 2 %
- A higher concentration of photocatalyst PC 1467 can help to improve the curing

- High UV dose
- D-Bulbs
- Lower line speed
- 40 – 50 % rel. humidity
- High SiCtwt
TÉGO® RC Silicones – Epoxy Silicones

Limited Cure Time Available

Example
- 250 m/min. line speed
- UV Unit to rewind 4.5 m
  - 1.1 sec. cure time
**TEGO® RC Silicones – Epoxy Silicones**

Post curing

A low degree of cure during production may disappear after 24 hrs of storage. Thus subsequent adhesion test is not suitable for quality control.

... means

If the silicone is not sufficiently cured in the moment of rewinding or in-line adhesive coating this can cause:

- Varying release values
  - liner: high release
  - laminate: low release
- Rub off (may disappear after post curing)
- Silicone transfer to back side
- Silicone transfer to adhesive, thus lower tack
TEGO® RC Silicons – Epoxy Silicons

Epoxy silicones offer benefits with the right substrate

Paper release liner
special alkaline free papers, e. g.
SAPPI Algro Sol C (37 – 80 g/m²)
Business Forms: with high coat weight

Filmic substrates

BOPP
- CR 30 or CR 50
- 2011 MFN
- PM, S1M and S2G
- MSO
- 30 MB 400
- Poli M514
- Innovia films (B)
- Superfilm (TR)
- Manulifilm (I)
- Trias Sentosa (ID)
- Exxon Mobil
- Polinas (TR)

PET ®Hostaphan (Mitsubishi Polyester Film)
(3 % TEGO® RC1480 for anchorage recommend)
®Hostaphan WDW 50 CSRE
®Hostaphan SP36
®Hostaphan WO 50 D027B
®Hostaphan GN 36 4600
®Hostaphan RN 30 23SB
®Hostaphan RNK
TEGO® RC Silicones – Pilot Lines

Headquarters in Essen/Germany
Global sales (●) and distribution network
Production facilities for RC Silicones (●)
RC Technical Service Centres (●)
TEGO® RC Silicones – Pilot Lines

RC Pilot Line Essen/Germany

- Silicone coating/UV drying
- Adhesive inline coating dispersion acrylics hotmelts & UV hotmelts
- Inline/offline process
- Max. 500 mm working width roll width 520 mm outer Ø 600 mm
- Max. 100 m/min. line speed
- Production of release liners, tapes and label laminates
Lab coater Essen/Germany

• Equipped with a 5-roll coater, maximum web width of 150 mm
• Line speed can be varied to a maximum of up to 50 m/min
• IST inerted UV lamp 120 W/cm, adjustable in height
• Inline Corona treatment 1000 W over 150mm
• 3” core, maximum roll diameter of 400 mm, maximum weight of 25kg
Pilot Line for UV Siliconizing in Hopewell/USA

- Offset gravure coater
- Inerted ELTOSCH UV unit with 2 x160 W/cm UV lamps
- Web width 61 cm
- Substrate on 3 inch or 6 inch core
- Line speed 25 - 250 m/min.
Pilot Line for UV Siliconizing in Shanghai/China

- Gravure roll coater
- Inline corona treatment
- Web width 33 cm
- Substrate on 3” core
- Line speed max. 150 m/min.
Asian Mobile UV Unit for Narrow Web Applications

- Max. 580 mm working width
- Up to 150 m/min. line speed
- 80 W/cm arc UV lamps
- 570 mm length in web direction
- 560 mm height (opened)
- 50 m³/h nitrogen consumption at 100 m/min.
Latin America Mobile UV Unit for Narrow Web Applications

- Max. 700 mm working width
- 150 m/min. line speed and more
- Two 120 W/cm arc UV lamps
- 707 mm length in web direction
- Made by Germatec, Rio de Janeiro/ Brazil
TEGO® RC Silicones – Pilot Lines

European Mobile UV Unit for Narrow Web Applications

- 550 mm working width
- Up to 200 m/min. line speed
- 160 W/cm arc UV lamps
- 475 mm length in web direction
- 480 mm height (opened)
- 50 m³/h nitrogen consumption at 200 m/min.
- Made by Eltosch/Hönle/Germany
TEGO® RC Silicones

For more information please visit our website

www.evonik.com/tего-rc

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