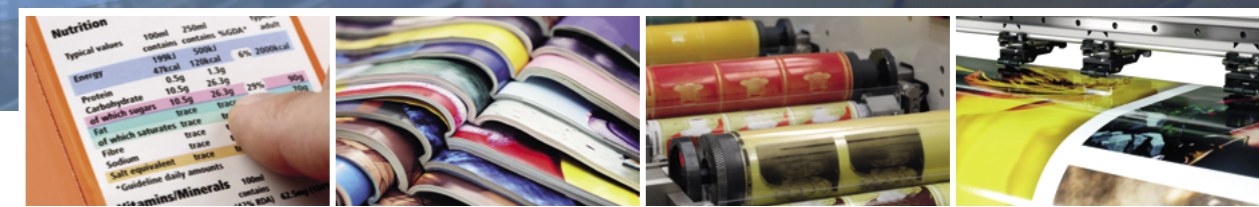


UV/EB CURABLE RESINS

EBECRYL® Resins for Indirect Food Packaging



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The operating allnex group is legally owned by Allnex Holdings S.à r.l., a company based in Luxembourg, which also provides long term strategic decisions relating to its investment in allnex.

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Facts & Figures

- Global company with over €2.1 billion in sales
- Broad technology portfolio: liquid coating resins, energy curable resins, powder coating resins, crosslinkers and additives, composites and construction materials
- Approximately 4000 employees
- Customers in more than 100 countries
- 32 manufacturing facilities
- 23 research and technology centers
- 5 joint ventures
- Extensive range of solutions for key coating segments: automotive, industrial, packaging coating and inks, protective, industrial plastics and specialty architectural

With manufacturing, R&D and technical facilities located throughout Europe, North America, Asia Pacific and Latin America, allnex offers global and reliable supply of resins and additives combined with local, responsive customer support.

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Energy curing technologies in food packaging applications

Energy curing (UV/EB) technologies have already made significant inroads into non-food applications due to the numerous advantages which they provide over other technologies, e.g. high gloss, excellent resistance properties, high printing speed, fast drying or cure times, no VOC, low system cost.

Penetration of these technologies into food packaging applications, however, is limited. Concerns

which are usually quoted are odor and taste transfer, migration of existing resins and of photo-initiators as well as chemicals of concern which are banned by brand owners and/or legislation.

To address above mentioned concerns, allnex is offering low migration resins as well as EBECRYL® LEO resins which are low migration resins with extra features as detailed below:

Improve migration control



Comparison of EBECRYL LEO resins to standard and Low Migration Resins

| | Standard | Low Migration | EBECRYL LEO |
|------------------------|-----------------------|--------------------------------------|---|
| Raw material selection | Technical performance | Technical performance | Technical performance |
| | Cost | Cost | Purity |
| | | | Cost |
| Production | ISO 9001 | ISO 9001 | ISO 9001 |
| | | Longer stripping | Longer stripping |
| | | Measures against cross-contamination | Extended Good Manufacturing Processes (GMP) |
| Quality Control | Physico-chemical | Physico-chemical | Physico-chemical |
| | | | Impurities |
| | | | Gas chromatography – mass spectrum (GC-MS) |

Good Manufacturing Processes

'Good manufacturing practice (GMP)' means those aspects of quality assurance which ensure that materials and articles are consistently produced and controlled to ensure conformity with the rules applicable to them* and with the quality standards

appropriate to their intended use by not endangering human health or causing an unacceptable change in the composition of the food or causing a deterioration in the organoleptic characteristics thereof.

* Commission Regulation (EC) N°2023/2006 of 22 december 2006 on good manufacturing practice for materials and articles intended to come into contact with food. Source: http://europa.eu/legislation_summaries/consumers/product_labelling_and_packaging/l12076_en.htm

Low migration

Low migration resins are designed for use in printing inks and coatings for indirect food contact.

They are made using selected components which should enable the formulation of low migration inks and coatings.

Those resins are produced under ISO 9001 standards and, similar to the EBECRYL® LEO range, measures are taken against cross contamination.

Good manufacturing processes for low migration resins



Low Migration Resins

| Product | Description | Functionality | Viscosity mPa.s, 25°C | Acid value mg KOH/g | OH value mg KOH/g | Color Gardner | Adhesion | Solvent Resistance | Reactivity | Flexibility | Pigment Wetting | Application Field | Key Features |
|-------------|--|---------------|-----------------------|---------------------|-------------------------|---------------|----------|--------------------|------------|-------------|-----------------|-------------------|---|
| EBECRYL® 45 | Polyether tetraacrylate | 4 | 160 | 0,5 | 60 | ●● | ●●● | ●●● | ●●● | ●● | ●● | L, F, I, O | High reactivity |
| EBECRYL 85 | Amine modified polyether acrylate | 3,3 | 160 | - | Amine Value 40 mg KOH/g | ●● | ●●● | ●●●● | ●●●●● | ●● | ● | F, S, I, O | High reactivity, low viscosity |
| EBECRYL 575 | Chlorine free polyester resin in EBECRYL 892 | - | 60 000 | 10 | 40 | (200) | ●●●● | ● | ●● | ●● | ●●●● | L, F, S, O | Good adhesion, good pigment wetting and good ink / water balance in offset inks |
| EBECRYL 820 | Polyester hexaacrylate | 6 | 600 | <10 | <25 | <10 | ●● | ●●● | | ●● | ●●●●● | F, S, I, O | Pigment dispersing resin for low migration flexo inks |
| EBECRYL 895 | Low viscosity DPHA | 6 | 7500 | <10 | 60 | <3 | ●● | ●●●● | ●●●●● | ● | ●● | L, F, S, I, O | Very high reactivity, high crosslinking leading to good hardness and scratch resistance |

| Product | Description | Solid Content | Viscosity mPa.s @ 25°C | pH | Max. average particle size | Molecular Weight | Tack-free before cure | Application Field | Key Features |
|---------------|---|---------------|------------------------|-----|----------------------------|------------------|-----------------------|-------------------|---|
| UCECOAT® 2804 | Sn-free, Aliphatic polyurethane acrylate dispersion | 35 | 75 | 7,5 | 100 | >10 000 | Y | I, O | Very high reactivity in both UV and LED cure, good adhesion onto plastic substrates |
| UCECOAT 2807 | Sn-free, Aliphatic polyurethane acrylate dispersion | 34 | <200 | 8 | 100 | 22 500 | Y | F, I, O | Versatile binder with good stability and reactivity, BPA-free and APEO-free |

| Product | Description | Viscosity mPa.s @ 25°C | Acid Value mg KOH/g | Color Gardner | Addition Level | Application Field | Key Features |
|----------------|----------------------|------------------------|---------------------|---------------|----------------|-------------------|---|
| EBECRYL LED 03 | Surface cure booster | 450 | - | colorless | 7 - 15% | F, I, S, O | Surface cure booster for low energy / LED cure conditions |
| EBECRYL LED 04 | Surface cure booster | 17 500 | - | colorless | 5 - 20% | L | Surface cure booster for low energy / LED cure conditions. Specific for lithographic applications |

| Product | Description | Type | State | Non-yellowing | Lithography | Flexography | Inkjet | Screen | OPV | Key Features |
|-------------|-----------------------------------|---------------|--------|---------------|-------------|-------------|--------|--------|-----|---|
| EBECRYL P39 | Polymeric benzophenone derivative | H-abstraction | Liquid | Y | Y | Y | Y | Y | Y | Photoinitiator for low odor UV coatings. No yellowing in thin layers (<6 µm) typical for OPV. Can be used in inks in combination with other photoinitiators |

F - Flexography
I - Inkjet
L - Lithography
O - Over print varnish
S - Screen

● - ●●●●●
Poor/Low - Very good/High

EBECRYL® LEO resins (Low Extractables and Low Odor)

EBECRYL LEO resins offers valuable options for producing inks and OPVs for indirect food packaging that meet brand owners' requirements and demanding regulations particularly those intended for use with human foods, pet foods, pharmaceuticals and similar products.

Key properties

- Low residual odor after curing and low taste transfer
- Low migration
- Use high purity materials
- Non mutagenic

EBECRYL LEO resins allow for the creation of high performing inks and OPVs with very low migration potential and enhance the ability to achieve high gloss and excellent print quality.

They are suitable for a variety of packaging materials, such as labels, lidding films and foils, wrappers and shrink sleeves.

Raw materials selection

In order to meet this challenging product profile new qualities of raw materials have been developed with raw material suppliers. Inhibitors with food contact clearance have also been selected.

Production process

The Low Extractable / Low Odor (LEO) resins design process includes a master strategy for minimizing the transfer of acrylates from the packaging matrix. This is based on increasing the size and cross-link density of the resin components. This strategy limits the migration of acrylate resins into food, under normal conditions of use, in conformance with e.g. the Swiss Ordinance on Materials and Articles in Contact with Food (SR 817.023.21) often used as "industry standard".

Good Manufacturing Processes for EBECRYL® LEO

EBECRYL LEO resins are produced following Good Manufacturing Practices (GMP).

EBECRYL LEO resins are subject to a stricter quality control process. GMP calls for taking the following measures at all stages during the manufacture of food contact materials:

- **Raw materials** qualities suitable for food contact are selected. Food contact specifications (e.g. special purity criteria) are set-up and documented. Traceability is requested at the supplier site.
- Specific rules are followed for the **manufacturing** of the EBECRYL LEO:
 - A specific layout is adopted for the production log sheets
 - Any deviation from the instructions, recipe or process change is reported to the Product Stewardship and Regulatory Affairs department, which then re-assesses compliance
 - Batch to batch cross contamination is avoided by optimizing the production sequence and/or by producing in campaigns and/or cleaning reactor and piping before production
 - Internal specifications are set and documented on potential contaminants
 - Extra care is taken to avoid contamination of finished products during **storage and transport**.



Toxicology for printing inks on the outside of food packaging

EBECRYL LEO resins have been tested for mutagenicity following OECD guidelines for the testing of chemicals and are considered non-mutagenic based on the "weight of the evidence" of available mutagenicity test results and are considered non-genotoxic.

EBECRYL LEO resins

| Product | Description | Functionality | Viscosity mPa.s @ 25°C | Acid Value mg KOH/g | OH Value mg KOH/g | Color Gardner | Adhesion | Solvent Resistance | Reactivity | Flexibility | Pigment Wetting | Application Field | Key Features |
|-------------------|--|---------------|------------------------|---------------------|-------------------------|---------------|----------|--------------------|------------|-------------|-----------------|-------------------|--|
| EBECRYL LEO 10101 | Self curing acrylate resin | 3 | 3500 | <1 | <25 | - | ●● | ●●● | ●●●●● | ●●● | ● | F, I, S, O | Use at 20 - 30% in formulation |
| EBECRYL LEO 10103 | Self curing acrylate resin | 3 | 6000 | <1 | <25 | - | ●● | ●●● | ●●●● | ●● | ●● | L, F, I, S, O | Use at 15 - 20% in offset ink formulation |
| EBECRYL LEO 10501 | Diluting triacrylate | 3 | 80 | 0,5 | <25 | (200) | ●● | ●●● | ●●● | ●● | ●● | L, F, I, S, O | Good diluting power. Good cure speed |
| EBECRYL LEO 10502 | Polymeric tetraacrylate | 4 | 170 | 5 | - | ●● | ●●● | ●●● | ●●● | ●● | ●● | L, F, I, S, O | Good reactivity with good flexibility. Best diluting acrylate for low migration applications |
| EBECRYL LEO 10551 | Amine modified polyether acrylate | 2,5 | 75 | - | Amine Value 56 mg KOH/g | ●● | ●● | ●● | ●●● | ●● | ● | F, I, S, O | Good diluting power with very good cure speed |
| EBECRYL LEO 10552 | Amine modified polyether acrylate | 3,5 | 450 | - | Amine Value 40 mg KOH/g | ●● | ●●● | ●●● | ●●●●● | ●●● | ● | F, I, S, O | Good deep cure and higher flexibility. Good adhesion |
| EBECRYL LEO 10553 | Amine modified polyether tetraacrylate | 3,4 | 220 | - | Amine Value 28 mg KOH/g | ●● | ●● | ●●● | ●●●● | ●●● | ● | F, I, S, O | Good reactivity with good flexibility. Best amino acrylate for low migration applications |
| EBECRYL LEO 10801 | Polyester hexaacrylate | 6 | 48 000 | 10 | <25 | dark | ●● | ●●● | ●●●● | ● | ●●●● | L, F | Excellent pigment wetting and ink / water balance |

F - Flexography
I - Inkjet
L - Lithography
O - Over print varnish
S - Screen
● - Poor/Low
●●●●● - Very good/High

EBECRYL® LEO self-curing acrylate resins

Migration of low molecular weight photoinitiators into food is a major concern. Therefore, so-called polymeric photoinitiators have been developed for low migration UV inks and coatings. However, they may suffer from poor solubility in acrylates, resulting in poor ink flow and low reactivity which are problematic for high speed offset and flexo printing processes.

To solve these concerns, Allnex introduces its latest development in acrylated binder technology, which does not require an additional photoinitiator, reducing the risk of migration in indirect food contact applications and mitigating performance issues with printability.

Key Properties

- Molecular weight of about 1000 Dalton which is the limit above which a product is of “no toxicological concern”
- Very high purity to avoid low molecular weight impurities and / or residuals prone to migration
- Ability to generate free radicals upon UV irradiation
- No generation of low molecular weight breakdown products
- Build into the acrylate matrix formed during curing of inks or varnishes

Registration status

The table below summarizes the resins status for the following regulations/countries to date:

- REACH
- TSCA
- Canada DSL
- China
- Japan

EBECRYL LEO 10101 and EBECRYL LEO 10103 allow manufacturers of inks for indirect food contact applications access to high-performance, self-curing resin solutions that eliminate concerns about the migration of low molecular weight photoinitiators.

Self-curing acrylate resins, typically incorporated at 20-30%, do not affect ink flow and are suitable for use in ink formulations with different types of pigments. Finished inks based on EBECRYL LEO 10101 and EBECRYL LEO 10103 have good stability and gloss, similar to those of inks prepared with conventional binders and PIs.

Benefits

- No need for photoinitiators, but possible to combine with photoinitiators when required e.g. in highly concentrated inks
- High reactivity hence suitable for high-speed printing applications
- Liquid with very good compatibility with a wide range of acrylates facilitating use in production

As well as their assessment regarding:

- The 2019 Swiss revision of the Ordinance on Materials and Articles in Contact with Food (SR 817.023.21). It introduces new regulations on packaging inks requiring the positive listing of all substances used in inks and a scientific evaluation for those migrating above the detection limit of 0,01 mg/kg food.
- 2018 Nestlé Guidance Note on Packaging Inks - version from 21-02-2014
- More information available on request: PSRA-Customer-Requests@allnex.com

| Country | REACH | USA | Canada DSL | China | Japan | Swiss Ordinance | Nestlé |
|--|------------------|-------------------------------------|--|---|-------|-----------------|-----------------|
| EBECRYL® LEO 10101 | Yes ¹ | Yes | Direct import up to 10MT with “Matched Notification” | Simplified notification permit granted to allnex ³ | No | Ok | Ok ² |
| EBECRYL LEO 10103 | Yes | Yes | Direct import up to 10MT with “Matched Notification” | Simplified notification permit granted to allnex ⁴ | No | Ok | Ok ² |
| EBECRYL LEO 10501 | Yes ¹ | Yes | No | Simplified notification permit granted to allnex ⁵ | Yes | Ok | Ok ² |
| EBECRYL LEO 10502 | Yes ¹ | Yes | Yes | Simplified notification permit granted to allnex ⁶ | Yes | Ok | Ok ² |
| EBECRYL LEO 10551 | Yes ¹ | Yes | No | Simplified notification permit granted to allnex ⁷ | Yes | Ok | Ok ² |
| EBECRYL LEO 10552 | Yes ¹ | Yes | Yes | Simplified notification permit granted to allnex ⁸ | No | Ok | Ok ² |
| EBECRYL LEO 10553 | Yes ¹ | Yes | No | Simplified notification permit granted to allnex ⁹ | No | Ok | Ok ² |
| EBECRYL LEO 10801 | Yes ¹ | Yes | Yes | Simplified notification permit granted to allnex ¹⁰ | Yes | Ok | Ok ² |
| EBECRYL 45 | Yes ¹ | Yes | No | Simplified notification permit granted to allnex ¹¹ | Yes | Ok | Ok ² |
| EBECRYL 85 | Yes ¹ | Yes | No | Simplified notification permit granted to allnex ¹² | No | Ok | Ok ² |
| EBECRYL 575 | Yes ¹ | Yes | No | Simplified notification permit granted to allnex ¹³ | Yes | Ok | Ok ² |
| EBECRYL 820 | Yes ¹ | Yes | Direct import up to 10MT with “Matched Notification” | No | Yes | Ok | Ok ² |
| EBECRYL 895 | Yes ¹ | Yes | Yes | Yes | Yes | Ok | Ok ² |
| UCECOAT® 2804 radiation curing resins | Yes | Yes - SNUR | No | Simplified notification permit granted to allnex for R&D samples with limited quantities ³ | No | Ok | Ok ² |
| UCECOAT 2807 radiation curing resins | No | Yes | Yes | Simplified notification permit granted to allnex ³ | No | Ok | Ok ² |
| EBECRYL LED 03 | Yes | Yes, for import only by allnex | Direct import up to 10MT with “Matched Notification” | Simplified notification permit granted to allnex ³ | No | Ok | Ok ² |
| EBECRYL LED 04 radiation curing resins | Yes | No PMN Submitted - Under EPA Review | No | Simplified notification permit granted to allnex ³ | No | Ok | Ok ² |
| EBECRYL P39 | Yes | Yes | No | No | No | Ok | Ok ² |

¹ Produced in EEA.

² Although not intentionally added, unavoidable traces of acrylates listed in exclusion list (table 3) or minimize list (table 4) or solvent listed in exclusion list (table 5) or in minimize list (table 6) might be present.

³ Legal specific permit to ship the formulation can be acquired by joint notification.

