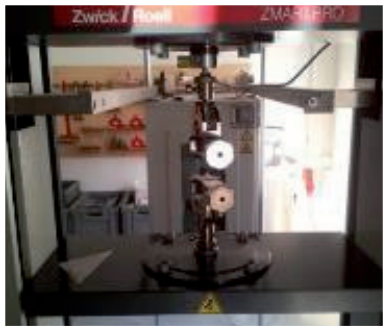
Film laminating adhesives



Processing information for film laminating adhesives

Jowat Klebstoffe

Film laminating adhesives

1. General information

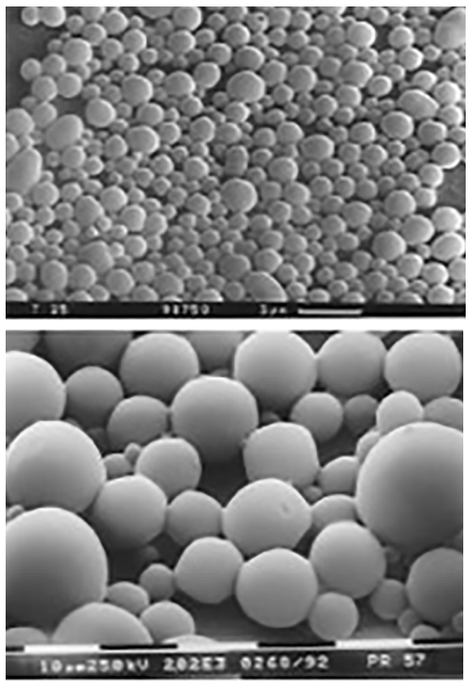
From a chemical point of view, film laminating adhesives of the **Jowacoll® 764.xx** series are dispersion adhesives based on acrylate copolymers. They were specially developed for film laminating applications and provide a wide range of adhesion to the printing inks and films used in print finishing (e.g. OPP, PET, acetate or compostable films).
Beyond that, the film laminating adhesives of Jowat offer the following benefits:

- Low foaming and skin formation in the adhesive reservoir.
- Very good wetting, coating flow and film formation for a high gloss finish.
- Fast drying and high green adhesion for high production speeds.
- Good pumping characteristics and shear stability, to prevent specks, particles and stripes.
- Low maintenance for reduced setup times.

Jowacoll® film laminating adhesives are self-crosslinking and can be processed as one- or two-component systems (to see whether a product can be processed with a second component, please refer to the technical data sheet). In addition, many adhesives have been assessed and tested for use in packaging with food contact according to the requirements under EU 1935/2004.

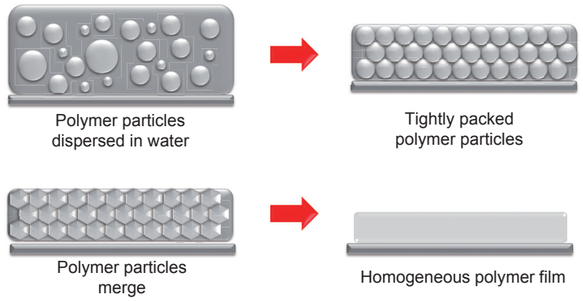
2. Characteristics of dispersion adhesives

Composition
Dispersion adhesives are a mixture of two phases. Solid plastic particles are evenly dispersed in an aqueous carrier. Depending on the type of dispersion, the size of the plastic particles can vary from 0.03 µm to 5 µm. They are so small that they are not visible to the naked eye. Only very finely dispersed products are used in print finishing applications, with particle diameters between approx. 200 and 800 nm (1 nm = 0.001 µm) that deliver a very clear and transparent adhesive film. The technical data sheets for the individual dispersions of the Jowacoll® series provide further information about the solids content, viscosity, pH value, as well as the adhesive characteristics and processing parameters of the corresponding adhesive.



Film formation

In order to bond two substrates together, the different adhesive systems must be liquid or in fluid form when applied on the foil. The film-forming and hardening mechanism that takes place when the adhesive dries is mainly a physical process. On drying, the aqueous dispersion evaporates, the plastic particles move closer together and eventually come into contact with each other. When all water has evaporated, the particles merge and the polymer chains flow together due to the high capillary pressure between the particles. The result is a strong adhesive film that ensures the bonding of the film and the printed material after lamination.



3. Directions for use and recommendations

Storage

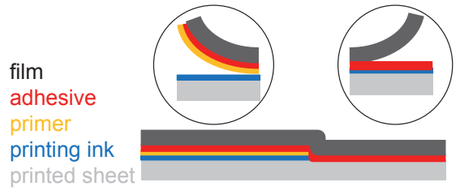
In general, dispersion adhesives should be stored at room temperature. Temperatures below 5 °C can lead to a premature coagulation of the plastic particles (clotting of adhesive components) and damage the dispersion. Under certain conditions, the plastic particles may settle on the bottom of the container after extended storage (sedimentation). If that happens, the dispersion can be made homogeneous again by stirring with a mixer. Skin which has formed on an already open container has to be removed before processing. Please observe that skin formation can always be a source of particles and could therefore cause stripes in the application. The containers should be closed hermetically whenever possible. Before processing, the adhesive should have a normal “processing temperature” of around 15 °C – 25 °C. Storage temperatures that are too low can lead to a limited coating flow of the adhesive on the substrates.

Conditions for good laminating results

All printing inks used should meet the requirements of DIN ISO 2836. Printing inks according to the standard have to be resistant against solvents (DIN ISO 2836, 6.2.2, 6.2.3) and alkali (DIN ISO 2836; 5.3). If special inks or Pantone inks are used, the colour pigment may bleed through after laminating. The printing inks must be completely dry before the laminating process is started. If necessary, the printed sheets may be aerated by restacking. Coated, cast-coated or calendered paper and cardboard are ideal for perfect laminating results. The surface tension of the films to be laminated as well as of the printing inks should be at least 38 mN/m. It is recommended to test the surface tension using test inks.

Film laminating adhesives

For a superior appearance, it is preferable to coat the printed sheets with a primer instead of using a print powder. Use a strip of adhesive tape to check whether the adhesion of the primer to the printing ink is strong enough. If the sheets to be laminated are already powdered, the powder should be removed as far as possible using the polishing roller or brush roller of the laminator. If this is not possible, the application amount of the adhesive should be increased to embed the print powder in the adhesive layer and to ensure a higher quality result. This prevents the graining from standing out on the laminated sheet and causing unwanted effects.



Before the dispersion is filled into the laminator

Print finishing is a high-end application that requires an absolutely clean processing unit, inside and outside. The slightest contamination (for instance aerosols from silicone sprays or oily rags used on printing units) can have an extremely detrimental effect on quality due to flawed wetting.
The rollers and cylinders inside the unit (application roller, deflection roller, drying roller, laminating cylinder, counter pressure roller) must be free of impurities.
The reservoir, pump, and hoses should be clean and free of adhesive residues. This is absolutely essential to ensure that no components enter the adhesive circuit.
The inlet connector of the supply line into the adhesive reservoir should have a filter installed on it (e.g. an 80 µm fine mesh filter).

Mixing instructions for 2-C adhesive system

For a manual mixing of the adhesive and the crosslinking agent, please follow the instructions below:

1.) Fill the crosslinking agent Jowat® 195.70/79 into a feeding container which is used exclusively for Jowat® 195.70/79.

2.) Canisters which were opened and have been in use have to be re-closed at all times to prevent any reactions with humidity.

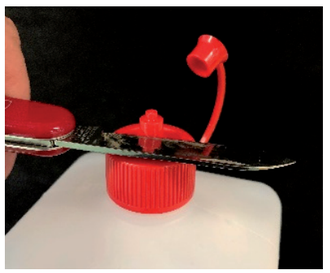
3.) Mixing the crosslinking agent Jowat® 195.70/79 with Jowacoll® 764.xx. An ideal mixing amount for the adhesive would be to limit it to 25 to 30 kg, so that it can be used up fast. Leftover amounts can be remixed with new batches, but should be reserved for operations which do not demand such high-quality surfaces. Please observe that the performance of an adhesive-crosslinker mixture where the crosslinking agent has exhausted its reactivity will be lower than the performance of the pure dispersion without crosslinking agent.

4.) The homogenisation is done with an electronically adjustable drill with rotor attachment.

5.) Fill the mixing container with Jowacoll® 764.xx, preventing foam formation as far as possible. Any foaming is eliminated by atomiser. The sprayed liquid consists of a water/alcohol (ethanol) mixture. The mixing ratio is 10:1.

6.) Start the mixer in the container filled with Jowacoll® 764.xx. Then add the crosslinking agent Jowat® 195.70/79 slowly and continuously at medium speed of the drill, approx. 1,000 rpm, over 90 seconds directly at the rotor and another 90 seconds, so that the crosslinker and adhesive may mix immediately and homogeneously.

7.) If the crosslinking agent is supplied in a 1.25 kg bottle, the cap has to be cut off and the crosslinker has to be added slowly and continuously.



Please ensure that the mixing is done with the least possible foaming to prevent the formation of particles due to drying (crystallisation).
The following are to be prevented:

- too high stirring speeds, which allows too much air to be mixed in
- immersion of the rotor not deep enough, which also leads to the effect above

Water-emulsifiable, aliphatic isocyanate crosslinking agents like Jowat® 195.70/79 also react with water and humidity. This causes side effects forming polyurea chains and possibly crystals that can cause particles. In order to keep this effect down as far as possible, the crosslinker must be incorporated as finely and homogenously as possible, and finished mixtures are to be processed as soon as possible. This reduces the risk of application failures like blade stripes later in the production process.

Film laminating adhesives

Recommended amount of crosslinking agent
If the laminated materials are exposed to high mechanical stress in downline processing, the recommended amount of crosslinker to be added is 1.5 – 5 %.

This applies especially if downline processing involves one of the following:

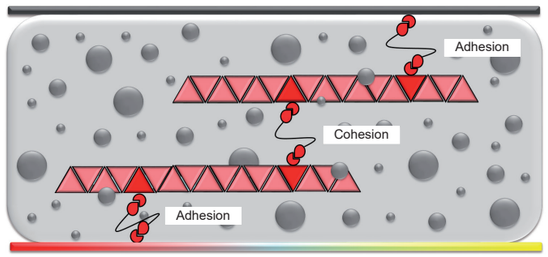
- creasing
- embossing
- hot foil embossing
- punching
- fold burning
- 3-knife + Plano trimming

The addition of a crosslinking agent is especially advisable if the films to be laminated have a high rigidity or are inelastic (e.g. acetate or PET films). This will make it easier for the laminated composite to compensate for the higher tension forces of the film when deformed (compared to “elastic” OPP films). Using a crosslinking agent is also recommended if the films to be laminated are thicker (e.g. 30 µm Forchheim films), because thicker films also expose the composite to higher tension forces.

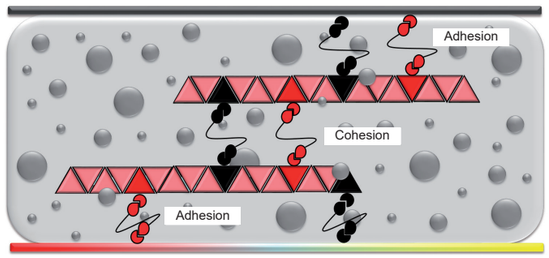
How crosslinking agents work
On the one hand, crosslinkers increases the degree of crosslinking of the polymer chains. This leads to a superior strength inside the adhesive layer (cohesion) and reduces the set-off risk at the paper edge in downline processing steps like punching or 3-knife trimming in bookbinding.

On the other hand, the crosslinker creates additional anchors on the substrates. This increases adhesion in the adhesive/film and adhesive/ink interphases and therefore minimises the risk of film delamination after creasing, embossing or folding. For an improved adhesion to be achieved it is essential that the film has previously undergone an adequate corona treatment. This has to be tested with test inks.

The higher cohesion coupled with the increased adhesion due to the addition of a crosslinking agent deliver an end product with superior compound strength and resistance.



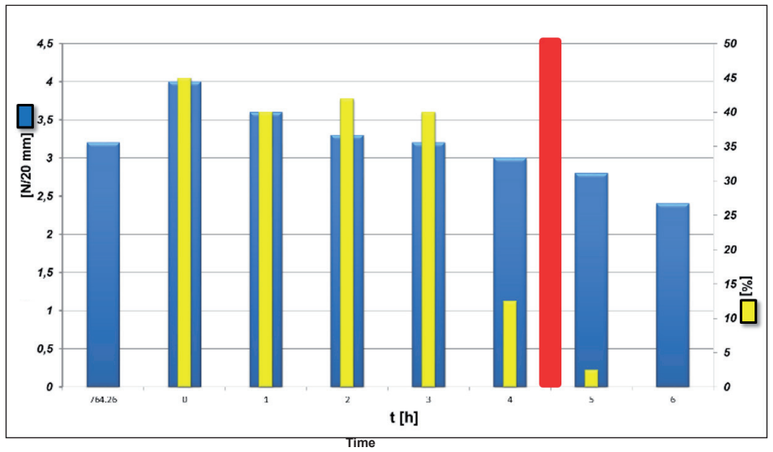
Jowacoll® 764.xx



Jowacoll® 764.xx + Jowat® 195.70/79

Pot life of a 2-C adhesive system

If a crosslinking agent is added to the dispersion, the pot life must be observed. Crosslinkers react with water to release CO_2 and form polyurea. That process reduces the reactivity of the crosslinking agent. Therefore, the performance of two-component systems will decrease over time.



The diagram shows how the adhesion of several laminates bonded with adhesive from the same batch falls over a period of 6 hours. While the just mixed adhesive batch has a peel strength ( ) of 4 N/20 mm, it has dropped to 3 N/20 mm after 4 hours. After 6 hours, the laminates have a peel strength of only 2.3 N/20 mm.

The decrease in strength is also coupled with a reduction in the amount of film tearing / separation ( ) when peeled, from 45 % (fresh batch) to 11 % (4 hours old batch).

In general, 2-C batches should therefore be processed within a pot life of max. 4 hours.

For a permanent supply of a 2-C dispersion adhesive, it may be beneficial to install a professional mixing system (for instance from EMT Dosiertechnik: www.emt-dosiertechnik.de/e/index.html) which can help processors achieve a higher product quality and reliability as well as reduce costs. The automatic metering facilitates a finer and more homogeneous blending of the crosslinking agent, which increases the performance compared to a manual mixing process. Under certain conditions, this can reduce the amount of crosslinking agent necessary.

Downline processing

How soon the laminated products are ready for downline processing depends on the type and amount of stress to that they are exposed, on the substrates and their characteristics, on the ambient conditions, on the machine parameters, as well as on how dry the printing inks are. Therefore, it is not possible give a general recommendation which applies in every single application.

The crosslinking process of 1-C systems is completed max. 3 days after laminating. When mixed with a crosslinker (2-C systems), the dwell time is reduced to 24 h, in individual cases to 12 h. The processor has to determine the time necessary before downline processing in each individual application by testing.

Film laminating adhesives

4. Machine and process technology

Two different lamination procedures

Based on the process technology, commercially available laminators can be divided into two categories:

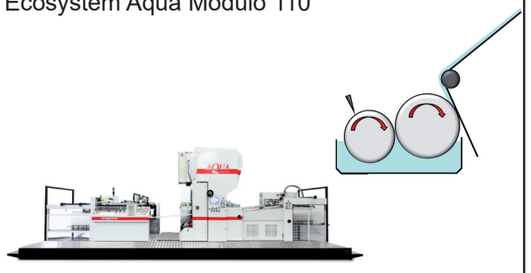
1.) Machines with a drying drum and separate laminating roller
(e.g. Eco System Aqua 110, Billhöfer FK).
Benefit: Easier processing of heat-sensitive films due to the separately controlled temperature of the two rollers.

2.) Machines with a combined drying and laminating roller (e.g. Billhöfer EK, TPM)
Benefit: The high line pressure in the laminating nip has a positive effect on surface gloss and composite strength.

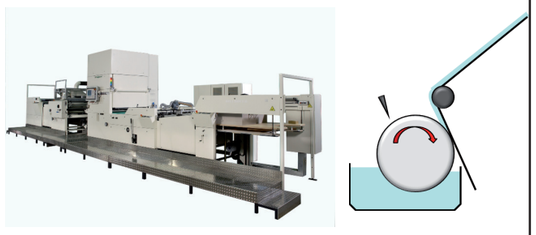
Two different application technologies

In addition to the different process technologies, laminators also use different application technologies. There are two types of application units that have become established on the market: Two-roller applicators with a metering roller incl. a scraping blade and an application roller (e.g. Eco System units), as well as applicators with a metering blade and an application roller (e.g. Billhöfer units). With both technologies, Jowat adhesives can be applied homogeneously, evenly, and without stripes on the films.

Ecosystem Aqua Modulo 110



Billhöfer EK 104 Highline



Recommendations and directions for use

- Machines and units should be clean on the inside as well as on the outside.
- The sheet feeder and guide should be configured to match the substrates to be laminated. A smoothly running process with correct sheet feeding will reduce machine stops and waste, and therefore save costs.
- For perfect laminating results, pressure should be as high as possible. Under certain conditions it may however be beneficial if the laminating pressure is reduced for thinner paper types (60 – 100 g/m²), to ensure a crease-free supply of the sheets into the laminating nip and to improve the flatness of the sheets.
- The film coated with adhesive has to be dried to initiate the film-forming process due to evaporation of the dispersion. On the one hand this is done by the contact heat of the drying and laminating roller as well as by a hot air system integrated in the laminator.

The temperature windows specified in the table below have proved beneficial:

	OPP films	PET + metallised PET films	Acetate + PE films
Temperature laminating roller [°C]	80 ± 10	85 ± 10	60 ± 5
Temperature drying roller [°C]	70 - 80	70 - 80	70 - 90
Air jet [°C]	70 - 90	70 - 90	70 - 90

The temperatures indicated above are to be seen only as a guideline and may vary or deviate depending on the job structure. When dry, the adhesive is homogeneous and highly transparent. Heat and high laminating pressure ensure a good adhesion to the printing inks and paper.

The application amount of the adhesive should be adapted to the following:
- The sheet's colour palette: Dark colours and large colour areas require higher application amounts to achieve a good coverage and depth without greying.
- The film type used: Especially frosted (matt or SoftTouch) or embossed films may require an increased application amount to prevent grey fog in the lamination.
- The quality of the cardboard: Cardboard with a matt, rough or uneven surface structure also requires a higher application amount to level out any unevenness.

After the laminated sheets have been taken out from the machine, they should be stored at room temperature to facilitate the curing and crosslinking process. Lower ambient temperatures will reduce the speed of that process.

Cleaning
When the laminating wok is finished, all machine parts that came into contact with the adhesive (adhesive reservoir, hoses, pumps, filters) should be flushed and cleaned with lukewarm water and cleaning concentrate Jowat® 192.40. Dry adhesive can be removed with the cleaner Jowat® 401.30 (please observe the instructions in the safety data sheet).

5. Quality assurance measures for processors

- If the sheets are coated with a printing primer, the primer's adhesion to the printing ink should be tested with an adhesive tape.
- It is recommended to check the surface tension with a suitable e.g. test ink. This is particularly important for OPP films.
- The surface tension of digital prints should also be tested (possibility of silicone in the toner).
- If the printing inks have a strong odour, it should be verified that they are dry enough for laminating. Depending on the type of inks used, they may cause swelling if they are not sufficiently dry before laminating (film swelling due to the migration of mineral oil components from the printing ink).

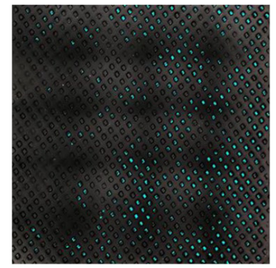
Film laminating adhesives

6. Services provided by the Application Technology Department of Jowat

High-gloss lamination is a process in which different substrates with differing surface properties and characteristics are bonded into a strong composite using an adhesive system. It is only natural that, in the worst case, delamination or other failures may occur in the finished, laminated product due to the complexity of the materials and substrates, the incompatibility of the different materials, or wrong process parameters.
Within the scope of its technical support and service, Jowat provides expert advice and assistance to determine the possible failure causes.

Determination of peel resistance
In the first stage, the peel strength of the laminated product is tested on samples supplied by the customer using a ZWICK® tensile tester. In this procedure, the film is peeled off under defined conditions. Based on the values measured, the laminated composite can then be assessed according to FOGRA (Research Institute for Media Technologies) as follows:
Sufficient film adhesion limit: > 1,3 N/cm
Delamination risk: 0,5 – 1,3 N/cm
Insufficient film adhesion: < 0,5 N/cm
In addition, the failure pattern (adhesion, cohesion or mixed failure) can also show whether the individual substrate surfaces are suitable for the bonding process.

Digital microscopy
In a second stage, the laminated composite may undergo standardised embossing for testing purposes in the lab. A digital microscope is used to determine the amount of delamination and evaluate the composite's suitability for downline processing like embossing or creasing.
In addition, the digital microscope facilitates a detailed examination of areas that allow conclusions regarding the failure cause based on the failure pattern (photo: delaminated film in creased area).



Infrared ATR spectroscopy
Based on the IR spectra of an ATR spectroscopy it is possible to analyse the chemical composition of a surface. For instance, it can be determined whether and even how much crosslinking agent was used.
It should be observed that suitable samples (printed sheet, film, failure samples) are essential for a correct failure analysis.
Processors should therefore retain samples of the films and printed sheets before as well as after lamination.

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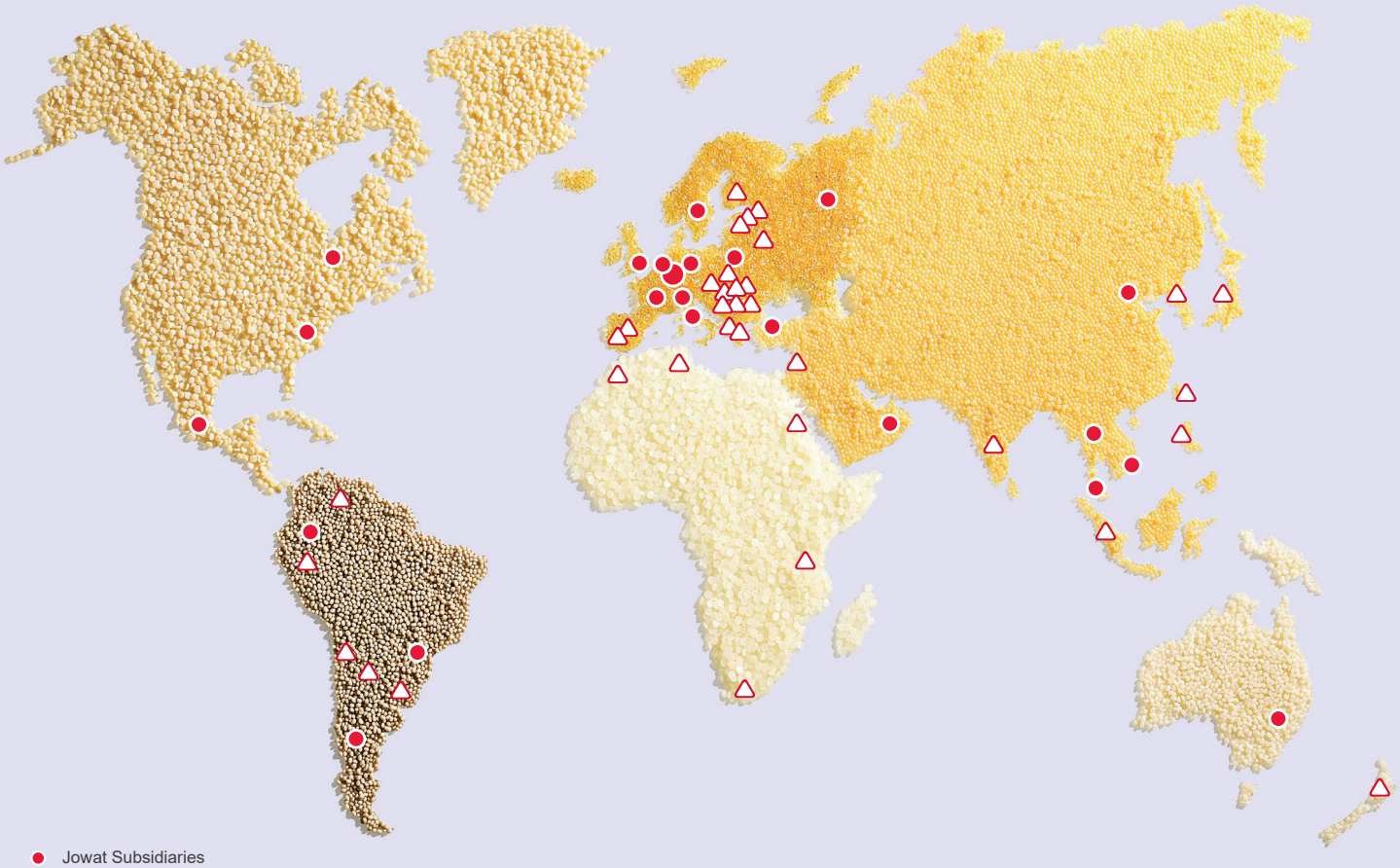

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