FEICA The European voice of the **adhesive** and **sealant industry**

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Terminology and definitions to be used in the context of plastic packaging recycling

FEICA, the Association of the European Adhesive & Sealant Industry, is a multinational association representing the European adhesive and sealant industry. Today's membership stands at 15 National Association Members, 24 Direct Company Members and 19 Affiliate Company Members. The European market for adhesives and sealants is currently worth almost 17 billion euros. With the support of its national associations and several direct and affiliated members, FEICA coordinates, represents and advocates the common interests of our industry throughout Europe. In this regard, FEICA works with all relevant stakeholders to create a mutually beneficial economic and legislative environment.

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Background and objective of the document

FEICA is aware of several different stakeholders publishing guidelines on plastic recycling, including requirements for adhesives in plastics recycling. Divergent terminology is used in these guidance papers, and this terminology also often differs from what is used in the adhesives industry and by users of adhesives.

Therefore, FEICA would like to assist stakeholders in furthering a common understanding of adhesives and the requirements that are important for adhesives in plastic recycling. A common language and technically sound definitions will help to ensure a better understanding amongst stakeholders and an easier exchange of expertise.

Classification of adhesives used in plastic packaging

Adhesives can be classified by their chemistries as well as by their function. In plastic packaging, the following adhesives chemistries and functions can be found:

Adhesive chemistries used in or on plastic packaging

1. Polyurethane adhesives

Polyurethane adhesives are based on reactive chemistry where isocyanates react with polyols and /or water. The high thermal resistance of polyurethanes, including the ability to withstand retort processes, results from chemical crosslinking. This crosslinking is achieved either through the use of a **two-component liquid polyurethane** adhesive system or through moisture curing of a one-component **reactive polyurethane adhesive**. In the case of liquid adhesive systems, solvent can be added to one or both components to reduce their viscosity.

2. Adhesives based on acrylic resin dispersions / emulsions

Polymer dispersions are systems in which polymer particles are dispersed in water.

Dispersions based on acrylic resins (polymers) offer high initial bond strength. The setting of acrylic dispersion adhesives occurs by evaporation of water. To increase the thermal and chemical resistance of acrylic dispersions, they can be crosslinked with isocyanates.

3. Adhesives based on natural polymers

Adhesives based on natural polymers are derived from either animal or plant material.

In the case of animal sources, the polymeric substances are typically proteins, such as casein. In the case of plant sources, they are generally carbohydrates, such as starch. Adhesives can also contain mixtures of animal- and plant-based polymers, combined with synthetic polymers as well.

As natural polymers are typically hydrophilic, they are generally dissolved in water in the form of so-called colloidal solutions[1]. A special case is natural rubber latex, which is not hydrophilic and forms a dispersion in water. The setting of the adhesive occurs, in either case, by evaporation of water.

1 A mixture that has particles ranging between 1 and 1000 nanometres in diameter yet still able to remain evenly distributed throughout the solution.

4. Polyolefin- / EVA-based hotmelt adhesives

Polyolefins as wells as ethylene vinyl acetate copolymers (EVA) are thermoplastic polymers that are employed in (non-reactive) hotmelt adhesives.

Non-reactive hotmelts adhesives belong to the group of physically setting adhesives, where the setting takes place without any chemical change to the polymer. Before application, the adhesive is heated and starts to melt, typically at temperatures above 100 °C. The adhesive is then applied in liquid (molten) form to the substrate. A physical setting takes place during cooling and turns the hotmelt back into a crystalline or amorphous solid.

Non-reactive solvent-based adhesives

A range of non-reactive, non-crosslinked polymers can be fully dissolved in organic solvents. Such solutions can be used to lay down coatings on paper and more typically plastic substrates by a coating and subsequent drying step. Such coatings can function as adhesives in specific conditions.

Functions of adhesives in or on plastic packaging

1. Labelling (not self-adhesive)

Most rigid packaging uses labels to present marketing and legal information on the product. Labelling provides multiple benefits over direct printing, such as higher flexibility in production and the ability to reuse or recycle the container more readily after the removal of the label.

A wide range of adhesives is used for labelling. In the case of paper labels, water-based adhesives such as acrylic dispersions or, more traditionally, adhesives based on natural polymers are used. For attaching non-absorbent label materials, i.e., plastic labels, non-reactive hotmelt adhesives are typically used.

2. Pressure sensitive applications

Pressure sensitive applications are used in the production of some self-adhesive labels. Adhesion can be permanent, or the label can be (easily) peelable by hand. Pressure sensitive applications are also used for re-closable food packs and re-closable lids.

Commonly, acrylic dispersions are used to produce pressure sensitive adhesives. In certain cases, non-reactive hotmelt chemistry can also be used.

3. Lamination

Most flexible packaging is composed of two or more layers, each fulfilling a certain function, such as sealability, product protection, and tear or puncture resistance. These layers need to be bonded together by adhesives.

The most common technology in use is polyurethane laminating adhesives as they exhibit excellent resistance to filling goods and thermal stress as well as low migration potential due to their reactive nature. Acrylic dispersions can also be used to produce multi-layer lamination for flexible packaging.

4. Cold seal

Cold seal adhesives are used to seal the edges of packaging made from a wide range of different substrates such as paper and PP or PE films.

As pressure-activated systems, no heating is required to obtain the seal: two cold seal coated sides only have to be pressed together. Cold seals are typically sealed within a temperature range of 15 to 25 °C, and the absence of heat makes them ideal for packaging temperature-sensitive foodstuff such as ice cream, chocolate or biscuits.

Cold seals typically contain a blend of natural rubber latex and acrylic dispersions.

5. Heat seal

Heat sealing refers to the combining of two substrates via heat and pressure. This process is predominantly used for lidding applications, where paper, aluminium or plastic lids are bound to plastic food containers, for example, in the packaging of dairy products; for plastic trays for convenience food and meat and for instant noodle cups. Heat seals are also used for the sealing of medical packaging.

Heat seal adhesives are in most cases non-reactive solvent-based products or based on acrylic dispersions, which are applied and dried on one or both substrates that will later be sealed together. In some cases, non-reactive hotmelts can also be used as heat seals.

Table I summarises typical utilisation of adhesives for plastic packaging by relating function to chemistry

Chemistry / Function	**Labelling**	**Pressure sensitive application**	**Lamination**	**Cold seal**	**Heat seal**
Polyurethane			X		
Acrylic resin dispersion / emulsion	X	X	X	X	X
Natural polymer-based adhesives	X			X	
Polyolefin / EVA hotmelt	X	X			X
Non-reactive solvent-based adhesives					X

Table I: Correlation between adhesive chemistry and function.

Relevant characteristics of adhesives in the plastic recycling process

Regardless of the chemistry or method of application, adhesive applications in recyclable plastic packaging (whether used in the packaging itself or on the label) must possess certain characteristics to ensure they do not interfere with the recycling process under consideration. Several stakeholders have published guidance documents that help packaging producers in making the right basic choices.

Each class of adhesive has its own behaviour, and adhesive manufacturers should be involved in the creation and update of guidelines and the evaluation of recycling options.

Terminology related to adhesive behaviour can differ between value chain actors and create misunderstandings. FEICA would like to contribute to establishing a common language and common understanding, thus making communication between the different actors easier.

FEICA therefore proposes the following definitions for adhesive behaviour during recycling:

Water-soluble / alkali-soluble adhesive application

Any applied adhesive capable of dissolving in water or alkali in the recycling process.

The dissolved adhesive is transferred into the process water and remains in solution until the washing liquid undergoes a recovery or cleaning step.

Releasable adhesive application

Any applied adhesive capable of releasing on at least one side of its bond under the specified conditions in the recycling process.

After releasing, the adhesive remains on one or on both substrates. The process water does not accumulate adhesives (it isn't recommended to recycle the washing solution).

- **Water releasable**: any applied adhesive capable of releasing on at least one side of its bond in water under the specified conditions in the recycling process.
- **Alkali releasable**: any applied adhesive capable of releasing on at least one side of its bond in alkali under the specified conditions in the recycling process.

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