

## The Solubility is the Solution

### The Company

BellandTechnology AG is a polymer technology company, originally founded in Switzerland 1983. BellandTechnology developed a proprietary „selectively soluble“ polymer and the proprietary polymer manufacturing process. The unique polymers are soluble in aqueous alkaline solutions and recyclable through subsequent precipitation in acids. Based on R&D and pilot plant operations, BellandTechnology is growing to an industrial technology leader. In cooperation with partners in industry and research we handle the demanding requirements of customers.

### The Products

BELLAND® *Polymers* are primarily acrylics based co- and terpolymers with defined solubility. These thermoplastic materials can be processed by standard polymer converting equipment. Under normal conditions they are water resistant but on demand the material can be dissolved in aqueous alkaline solutions. Different grades of BellandTechnology polymers cover a wide range of applications:

**extrusion, thermoforming, injection moulding, coatings, films, foams, fibres,  
lost core, hot Melts**

## Technology of Designed Alkaline Soluble Polymers

### Overview

BELLAND® *Polymers* are programmed to be soluble in alkaline solution, i.e.

- the moment of dissolving and
- the speed of the dissolving process

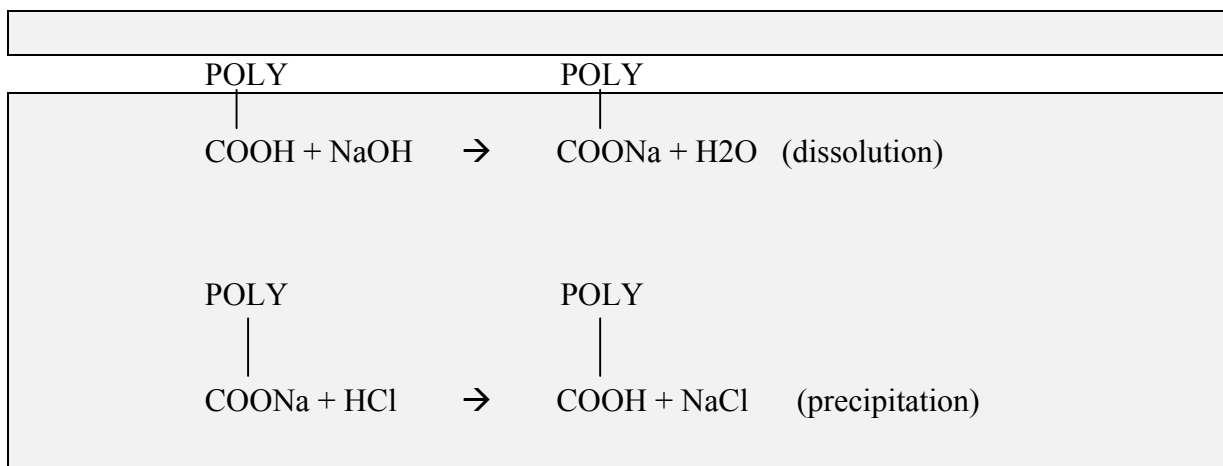
can be determined.

These effects can be achieved by using of carboxyl-containing Co- or Terpolymers. The start of dissolving is triggered by the contact of an alkaline solution with the polymer. The speed of the dissolution is controlled by the structure of the polymer chain (monomer types, molecular weight, molecular weight distribution), additives as well as type and concentration of the base.

The polymers are composed of hydrophobic (water repellent) and hydrophilic (water loving) components in such a way that they are resistant to neutral water but soluble in alkaline solutions (chemical: bases). BELLAND® Polymers are thermoplastics and can be used for the production of films, coatings, injection moulded articles, foam and adhesives and for temporary as well as for permanent applications.

The solubility in alkaline solutions allows the precipitation of the polymer with acids; this specific property renders Belland products easy to recycle or disposable.

The chemistry of BELLAND® Polymers is pretty simple and can be outlined as follows:



POLY- describes the backbone of a polymer chain, COOH describes the carboxyl group and COONa describes a (carbonated) sodium salt.

## Differentiation from Known Alkaline Soluble Polymers

There is a whole range of generally known alkaline soluble plastics, but in contrast to BELLAND®Polymers these products are always soluble in neutral water, the onset and speed of the dissolving process cannot be controlled. Most of these plastics are not thermoplastics and cannot be recycled easily.

Known alkaline soluble and with acids precipitable (reclaimable) Polymers such as Poly(meth)acrylic acid, Carboxymethylcellulose or certain Maleinic acid anhydrite-Copolymers are not thermoplastics or do not provide acceptable mechanical properties.

## The Solubility in Bases

BELLAND® products containing carboxylic groups are designed in a way so that they are not soluble in water in the not dissociated carboxylic state. After the neutralisation reaction, the salt however because of the easier hydration of the carboxylic anions becomes water soluble.

For the dissolution of BELLAND® products organic or in-organic bases can be used, i.e. 0,5 to 3,0% aqueous solution of caustic soda, caustic silicate, caustic carbonate, ammonium or ammonium carbonate.

In general, pH-Values of 11-14 dare desirable for the dissolution at ambient temperatures, at elevated temperatures lower pH-Values suffice.

With higher concentrated bases the solubility decreases in general. The best solubility at ambient temperatures is performed with ammonium.

## Precipitation with acids

As polycarbonic acids BELLAND®Polymers are weak acids, therefore their salts can be transformed water insoluble with stronger acids.

Stronger acids i.g. are inorganic acids like hydrochloric acid, sulphuric acid, phosphoric acid or organic acids like cytric acid or formic acid.

The amount of acid necessary for the precipitation depends on the type of polymer: Solutions of polymers rich in carboxylic groups need to be brought to a pH-Value of below 2 for the complete precipitation, whereas for low carboxylic polymers pH-Values of 3 to 4 are sufficient.

The precipitated Polymer can be separated from the waste water stream by filtration, or like with catering products, recycled to new products.

## **BELLAND® Polymer Applications**

### **Design and Processing**

BELLAND® Polymer is an alkali-soluble thermoplastic which is compatible with all commonly used processing methods.

BELLAND® Polymers are water-resistant. They can, however – and this is their unusual characteristic – be dissolved in aqueous alkali solutions if necessary. This combination of characteristics opens up an extremely wide range of applications. There are no limits to the creative potential for innovative uses.

Consider just a few examples:

#### **Fibres**

Fine fibres which are soluble in aqueous alkali solutions  
e.g. for temporary coating of other plastic fibres or as soluble woven or non-woven fabric.

#### **Films**

Hard or soft films  
e.g. for thermoformed products, for soluble labels or as a temporary carrier material.

#### **Foams**

Soluble foam  
e.g. for lost core applications, bobbin cores, placeholders which are removed later by dissolution, broad design latitude – freedom.

#### **Coatings**

Dissolved polymer for temporary coating  
e.g. as surface protection for high quality optical lenses or anti-tarnish protection for metals, production of structured surfaces possible by various printing processes.

## Lost Cores

Production of irregular hollow bodies  
e.g. as bobbin cores or placeholders.

## Bonding and Joining

BELLAND® *Hotmelt* is an alkali-soluble adhesive which can be applied using typical hot melt glue processing methods.

BELLAND® *Hotmelt* is water-resistant and can be washed out using conventional alkaline detergents without leaving any residue.

That means different components can be joined and then separated again by means of a simple washing process. There are no limits to the creative potential for innovative uses. Consider just a few examples:

### Labe Adhesive

Alkali-soluble adhesive – hot melt glue for labels  
e.g. transport container logistics labels, which can be removed without leaving any residue.

### Adhesive Tapes

Adhesive tapes with BELLAND® *Hotmelt* can be removed in simple wash processes without leaving residues.

BELLAND® *Hotmelt* has good adhesive properties and is dermatologically and biologically safe, so it can also be used in medical applications.

### Temporary Bonding

Alkali-soluble adhesives  
e.g. temporary bonding when machining materials in cutting or grinding processes. The adhesive layer can be easily removed without leaving any residues.

## Environment and Safety

Easy, safe and economical

BELLAND®*Polymer* and BELLAND®*Hotmelt* are often used only temporarily in processing steps. After fulfilling their function, aqueous alkali solutions can be used to remove them easily without leaving residues.

Aqueous alkali solutions are neither flammable nor volatile. As a rule, they are also non-toxic. As a result they offer the following advantages over adhesive removal processes that use organic solvents:

- . no costly fire and explosion-protection measures
- . no exhaust air purification
- . simplified occupation health and safety
- . no problems with VOCs (Volatile Organic Compounds)
- . no complex approval procedures
- . low investment costs
- . simplified automation
- . eco-friendly processing.