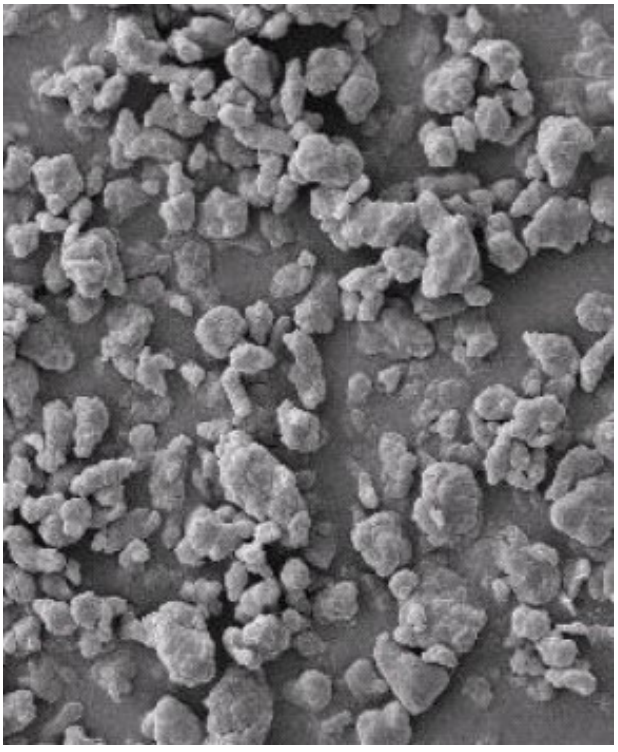
Coathylene®
Polymer Powders

Fine Powder binder for cathode rings in alkaline batteries

Electrochemically inert – High specific area – No influence on resistivity

Coathylene® fine powders are manufactured for specific applications. Our unique manufacturing processes along with our long-term expertise enable the fine tuning of our products, making them highly suitable for demanding applications.



Coathylene® - Fine thermoplastic powders

A patented chemical process that produces additive-free fine thermoplastic polymer powders. Constantly developing new techniques producing new powders is at the heart of our company strategy. Our R&D and marketing teams focus on niche applications requiring highly technical content. Our market leadership is ensured by our Research and Development capabilities to meet Customer demands, the ability to adjust our products to their application needs.

Axalta Polymer Powders Switzerland is established in the market place as the leading source of polymer powders. The expertise of our manufacturing engineers and our quality control team makes us the premier supplier with a strong history of consistency in quality.

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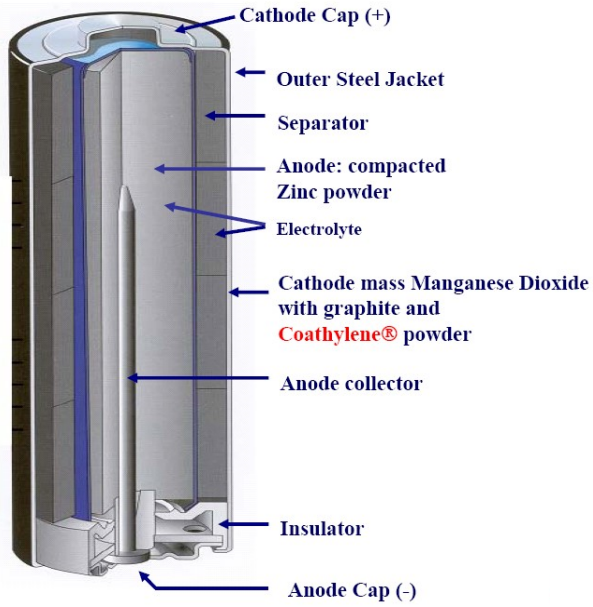
Coathylene® is used as a Binder in the cathode mass of alkaline batteries

Technical requirements for binders

- Electrochemical inert
- Free of ionic substances
- Free of metal traces
- Solid state material
- Long term binding capability
- No impact on resistivity
- Compatible with KOH
- Particle size in line with graphite and MnO_2
- High specific area
- Dust control properties
- Consistency in quality
- Easy handling and dosing
- Environment compatible
- Non hazard to health



Courtesy of : TIMCAL SA

Typical composition of the cathode

High Purity Manganese Dioxide: CMD or EMD	**88.5 % – 89.5 %**
Graphite : Timrex MD 25 (Timcal)	**7 %**
Binder: Coathylene®	**0.5 % - 1.5 %**
Electrolyte: KOH	**3 %**

Electrochemical reaction

$$Zn + 2\ MnO_2 + H_2O \longrightarrow 2\ MnO(OH) + ZnO$$

The binder is added to the formulation at the beginning of the blending step process. **A quantity of 0.5 up to 1,5 % weight can be added**. No modification of the ratio MnO_2 // Graphite is necessary. The amount of KOH, also remains unchanged in respect to Graphite and MnO_2.

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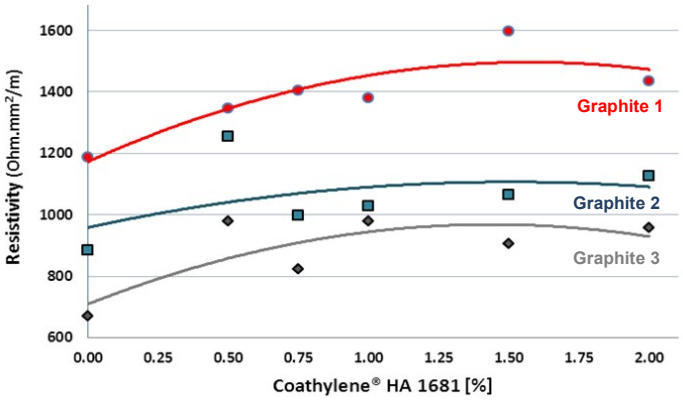
The main function of Coathylene®: Improved mechanical strength

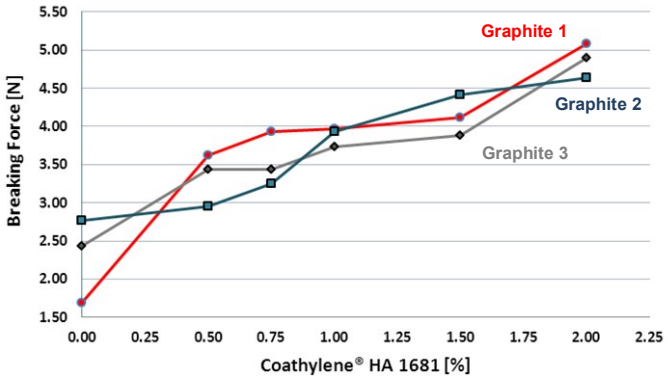
Good cathode mechanical strength is one of the key factors in battery technology, as it determines production efficiency. By adding a small amount of Coathylene® the breaking force of the cathode can be increased dramatically.

The addition of 0.5 to 1.5 % of Coathylene® improves the breaking force of the cathode mass significantly (c.f. Graph 1) without reducing the electrical properties (c.f Graph 2). The improvement of the mechanical strength can reduce the scrap by more than 50%.

Graph 1: Evolution of breaking force versus Coathylene® concentration



Graph 2: Evolution of resistivity versus Coathylene® concentration



High Purity

Coathylene® grades are free from impurities, thus having no interference with the electrochemical system. Controlled purity and particle size distribution of Coathylene® powders make them an ideal binder and are a recognized highly efficient processing aide.

Coathylene® is a polyethylene powder of high purity and is therefore electrochemically inactive. Coathylene® has excellent chemical resistance against KOH in water. Coathylene® powders are made out of pure low density polyethylene that contains trace metals within the following limits:

Metal	Concentration [ppm]
As	<1
Mo	<1
Sb	<1
Cd	<1
Co	<1
Pb	<2

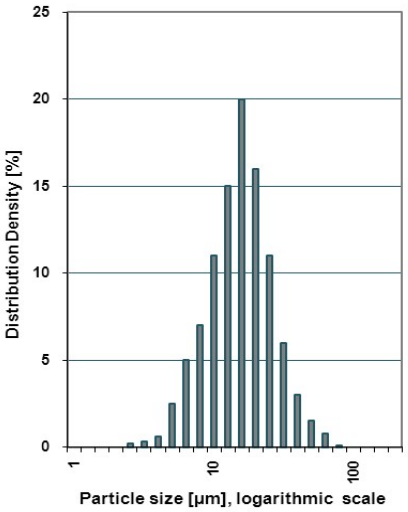
Metal	Concentration [ppm]
Fe	< 5
Ni	<1
Cu	<1
Cr	<1
Al	<1

To ascertain the above mentioned statement an analysis has been carried out at the Swiss Federal Laboratories for Materials Testing and Research (EMPA) in April 2009.

Particle size distribution

A predominant factor of efficiency is the narrow particle size distribution of the powder.

The particle size distribution matches Manganese Dioxide and Graphite powder. Coathylene®'s controlled particle size ensures small binding bridges. (Larger particles tend to coat Manganese Dioxide with an insulating film). 1g of Coathylene® powder contains 1000's of particles. Providing 1000's of binding bridges.



The narrow particle size distribution produces sharp edges when pressing the tablets or rings and gives a regular and optimum capillarity. The regular capillarity allows the absorption of a constant electrolyte amount. This provides a constant conductivity and longer life.

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Why is Coathylene® the preferred binder?

- **Its particle size distribution matches MnO_2 and Graphite**
- **No interference with the electrochemical reaction**
- **Reduction of dust formation while blending**
- **Increases bulk density, improving compaction**
- **Reduces scrap by more than 50%, depending on the process**
- **Conductivity is maintained due to the low amount required**
- **Contributes to the porosity of the system, enhancing ions transport by liquid electrolyte**
- **Required when very fine graphite is used in the formulation**

Overview of most common grades used as Battery binders*:

* Typical properties, not to be considered as specifications

Grade	*Units*	*Coathylene® HA 1681*	*Coathylene® HA 2454*
Polymer		LDPE	LDPE
Density	*g/ml*	0.916	0.924
Melting range	*°C*	98-113	106-119
Softening point	*°C*	70	91
Melt flow index (2,16kg/190°C)	*g/10min*	50-90	6-10
Water absorption (24h at 23°C)	*%*	0.01	0.01
Electrical dissipation factor		0.0003	0.0003
Elongation at break	*%*	220	470
Modulus of elasticity	*MPa*	140	230
Shore hardness (D)		36-40	45-49
Maximum particle size	*µm*	75	75
Average particle size	*µm*	12-22	12-22