19 March 2018

Altech Chemicals Ltd (ATC) BUY Share Price: A$0.16

HPA Critical to Lithium-ion Battery Market Target Price: A$0.41

Lithium-ion batteries, much like rocket fuel and explosives, contain an oxidiser (cathode) and fuel (anode/electrolyte) in a sealed container. If the cathode and anode are allowed to make direct contact, a highly exothermic reaction called a thermal runaway will commence. A porous membrane separator maintains the structural integrity in a battery and prevents a thermal runaway; it allows lithium-ions to travel between the electrodes without the two electrodes touching. As the energy density of batteries increase this separator becomes ever more important for a battery to operate safely. Altech's High Purity Alumina (HPA) is a crucial raw material for a new generation of separators which are coated in this inorganic material to greatly improve the thermal stability of the battery.

Evolution of Separators

- Most lithium-ion battery separators (LiBS) in use today are based on polyethylene (PE) or polypropylene (PP). PE has a melting point of 135ºC, and PP 155ºC. In a battery at these temperatures the polymers shrink and can expose the anode and cathode, starting a thermal runaway event.
- Some LiBS incorporate a "fuse" by combining PE and PP in a trilayer PP/PE/PP combination. If the battery reaches 135ºC, the PP layers remains stable but the PE layer melts and seals the pores, preventing lithium-ions travelling through the membrane and shuts down the battery.
- Enhancing the physical and chemical properties of the LiBS further, HPA particles are being introduced to create a composite separator that can withstand temperatures of >200ºC. HPA is being utilised by the world's leading LiBS manufacturers such as Celgard (AsahiKasei), SK, UBE and W-Scope in ceramic coated separator (CCS) products for use in high energy density batteries in XEVs and energy storage applications.

Demand for HPA to Accelerate

- The use of CCS was commercialised in c2008 and the technology has been adopted in line with increased demand from XEVs and energy storage applications. We expect the superior safety characteristics will begin to attract the attention of regulators and will eventually become widely adopted and potentially mandatory.

Separator Market to Boost HPA Demand

- Our base case assumption is for the separator market to grow to 19% of the HPA market by 2025 at a CAGR of 26%, our forecasts show the separator market consuming 11.3ktpa by 2025 (the equivalent of 2.5 Altech projects).

Company Data

Shares – ordinary (M)	426.5
Market capitalisation ($M)	68
12 month low/high ($)	0.10 / 0.26
Average monthly turnover ($M)	2
GICS Industry	Materials

Financial Summary (fully diluted/normalised)

Year end June	2020F	2021F	2022F	2023F	2024F
Revenue ($m)	0	0	76	140	174
Costs ($m)	1	1	32	46	53
EBITDA ($m)	-1	-1	44	94	121
NPAT ($m)	-2	-8	6	35	56
EPS (cps)	-0.4	-2.0	1.4	3.5	5.6
EPS growth (%)	na	na	169%	159%	57%
PER (x)	na	na	12	5	3
Cashflow ($m)	-2	-8	30	81	113
CFPS (cps)	0	-2	7	8	11
PCFPS (x)	-38	-8	2	2	1
Enterprise Value ($m)	176	317	293	218	111
EV / EBITDA (x)	-210	-378	7	2	1
Payout ratio (%)	0%	0%	0%	0%	0%

Board

Director	Position	Executive
Luke Atkins	Chairman	Non-executive
Iggy Tan	Managing Director	Executive
Peter Bailey	Director	Non-executive
Dan Tenardi	Director	Non-executive
Tunku Yaacob Khyra	Director	Non-executive
Uwe Ahrens	Alternate Director	Non-executive

ATC – performance over one year

Disclosure and Disclaimer

This report must be read with the disclosure and disclaimer on the final page of this document.

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Analysis

Altech Chemicals Ltd (ATC)

14-Mar-18

Year End June

Share Price	($)	A$0.16
Iss. Shares	(M)	426.5
Dilution	(M)	572.2
Fully Diluted	(M)	998.7
Mkt Cap.	($M)	A$68M

PROFIT & LOSS		**2018F**	**2019F**	**2020F**	**2021F**	**2022F**	**2023F**	**2024F**	**2025F**
Revenue	A$M	0	0	0	0	76	140	174	180
Operating Costs	A$M	0	0	0	0	31	45	52	56
Exploration	A$M	0	0	0	0	0	0	0	0
Other	A$M	5	1	1	1	1	1	1	1
EBITDA	**A$M**	**(5)**	**(1)**	**(1)**	**(1)**	**44**	**94**	**121**	**123**
D&A	A$M	0	0	0	0	21	31	33	31
EBIT	**A$M**	**(5)**	**(1)**	**(1)**	**(1)**	**23**	**63**	**87**	**92**
Net Interest	A$M	(0)	(2)	2	11	15	13	8	2
Pre-Tax Profit	**A$M**	**(5)**	**0**	**(3)**	**(12)**	**8**	**51**	**79**	**89**
Tax	A$M	(1)	0	(1)	(4)	2	15	24	27
Net Profit	**A$M**	**(3)**	**0**	**(2)**	**(8)**	**6**	**35**	**56**	**63**
Abnormal	A$M	0	0	0	0	0	0	0	0
Reported Profit	**A$M**	**(3)**	**0**	**(2)**	**(8)**	**6**	**35**	**56**	**63**
Dividends Paid	A$M	0	0	0	0	0	0	0	0
Adjustments	A$M	0	0	0	0	0	0	0	0

CASHFLOW									
Net Op Cash Flow	A$M	(5)	(1)	(1)	(1)	44	94	121	123
Net Interest	A$M	0	2	(2)	(11)	(15)	(13)	(8)	(2)
Tax Paid	A$M	1	(0)	1	4	1	0	0	(14)
Op Cash Flow	**A$M**	**(3)**	**0**	**(2)**	**(8)**	**30**	**81**	**113**	**107**
Net Capex	A$M	0	(132)	(132)	(132)	(6)	(6)	(6)	(6)
Exploration	A$M	0	0	0	0	0	0	0	0
Inv Cash Flow	**A$M**	**0**	**(132)**	**(132)**	**(132)**	**(6)**	**(6)**	**(6)**	**(6)**
Free cash flow	*A$M*	*(3)*	*(132)*	*(134)*	*(141)*	*24*	*76*	*107*	*101*
Net Borrowings	A$M	0	0	203	51	(20)	(70)	(80)	(76)
Dividends	A$M	0	0	0	0	0	0	0	0
Equity Issues	A$M	17	143	0	0	0	0	0	0
Other	A$M	0	0	0	0	0	0	0	0
Fin Cash Flow	**A$M**	**17**	**143**	**203**	**51**	**(20)**	**(70)**	**(80)**	**(76)**
Net Cash Flow	**A$M**	**14**	**11**	**69**	**(90)**	**4**	**6**	**27**	**24**

BALANCE SHEET									
Cash	A$M	15	26	95	5	9	15	41	66
Other Current	A$M	0	0	0	0	0	0	0	0
Cur Assets	**A$M**	**15**	**26**	**95**	**5**	**9**	**15**	**42**	**66**
Fixed Assets	A$M	23	155	288	420	426	432	438	444
Exploration	A$M	0	0	0	0	0	0	0	0
Other	A$M	0	0	0	0	0	0	0	0
Non Cur Assets	**A$M**	**23**	**156**	**288**	**421**	**427**	**433**	**438**	**444**
Total Assets	**A$M**	**39**	**182**	**383**	**426**	**436**	**448**	**480**	**510**
Borrowings	A$M	0	0	0	0	0	0	0	0
Payables	A$M	7	7	7	7	7	7	7	7
Other	A$M	0	0	0	0	0	0	0	0
Cur Liab	**A$M**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**
Borrowings	A$M	0	0	203	254	234	164	84	8
Provisions	A$M	0	0	0	0	0	0	0	0
Other	A$M	0	0	0	0	0	0	0	0
Non Cur Liab	**A$M**	**0**	**0**	**203**	**254**	**234**	**164**	**84**	**8**
Total Liabilities	**A$M**	**7**	**7**	**211**	**262**	**242**	**172**	**92**	**15**
Total Equity	**A$M**	**31**	**175**	**173**	**164**	**195**	**276**	**389**	**495**

RATIO ANALYSIS									
EPS	¢	(0.8)	0.1	(0.4)	(2.0)	1.4	3.5	5.6	6.3
PER	x	na	270.2	na	na	11.7	4.5	2.9	2.6
EPS Growth	%	17%	108%	-815%	-365%	169%	159%	57%	12%
CFPS	¢	(0.8)	0.1	(0.4)	(2.0)	7.1	8.2	11.3	10.7
PCFR	x	na	270.2	na	na	2.3	2.0	1.4	1.5
DPS	¢	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yield	%	0%	0%	0%	0%	0%	0%	0%	0%
Payout Ratio	%	0%	0%	0%	0%	0%	0%	0%	0%
Gearing ND/E	%	-48%	-15%	63%	152%	116%	54%	11%	-12%
Interest Cover	x	18.5	0.8	na	na	1.6	5.0	10.9	38.5
EBITDA Margin	%	na	na	na	na	58.2	67.2	69.4	68.3
EBIT Margin	%	na	na	na	na	30.7	45.1	50.4	51.0
Return On Assets	%	(12.8)	(0.7)	(0.2)	(0.2)	5.4	14.1	18.2	18.0
Eff Tax rate	%	30%	30%	30%	30%	30%	30%	30%	30%

		2018F	**2019F**	**2020F**	**2021F**	**2022F**	**2023F**	**2024F**	**2025F**
Reserve									
HPA									
Tonnes	Mt			1.36					
Grade (Al2O3 %)	%			30%					
Contained Al2O3 (kt)	kt			408					

HPA									
Production									
Ore Processed	kt	0.0	0.0	0.0	0.0	23.1	36.7	42.5	43.5
Ore Grade	%	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3
Overall Recovery	%	0%	0%	0%	0%	38%	38%	38%	38%
HPA Produced	kt	0.0	0.0	0.0	0.0	2.4	3.8	4.4	4.5
HPA Sold	kt	0.0	0.0	0.0	0.0	1.9	3.5	4.3	4.5
C1 Costs	**A$'000/t**	**-**	**-**	**-**	**-**	**10.9**	**9.8**	**9.8**	**10.4**
AISC	**A$'000/t**	**-**	**-**	**-**	**-**	**15.2**	**14.1**	**14.1**	**14.7**

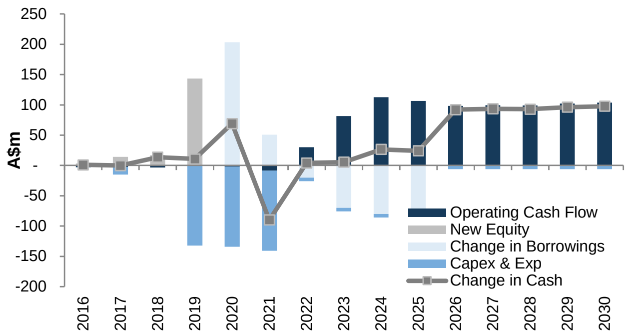
REVENUE									
HPA Project	A$M	0	0	0	0	76	140	174	180
Total	**A$M**	**0**	**0**	**0**	**0**	**76**	**140**	**174**	**180**

OPERATING COSTS									
Meckering (Mine)	A$M	0	0	0	0	3	0	0	3
Direct Processing	A$M	0	0	0	0	17	28	32	33
Transport	A$M	0	0	0	0	2	3	3	4
C1 Cash Cost	A$M	0	0	0	0	26	37	43	47
Royalties	A$M	0	0	0	0	5	8	9	9
Corporate	A$M	0	0	0	0	0	0	0	1
Total	**A$M**	**0**	**0**	**0**	**0**	**36**	**53**	**62**	**66**

CAPEX									
Project	A$M	0.0	132.4	132.4	132.4	0.0	0.0	0.0	0.0
Sustaining	A$M	0.0	0.0	0.0	0.0	6.0	6.0	6.0	6.0
Total	**A$M**	**0.0**	**132.4**	**132.4**	**132.4**	**6.0**	**6.0**	**6.0**	**6.0**

ASSUMPTIONS									
Exchange Rate	A$/US$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Interest Paid	%	3%	3%	3%	3%	3%	3%	3%	3%
Interest Rec	%	2%	2%	2%	2%	2%	2%	2%	2%
Diesel Price	A$/L	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Gas Price	$6/GJ	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
HPA Price	US$/t	30000	30000	30000	30000	30000	30000	30000	30000
HPA Price	A$/t	40000	40000	40000	40000	40000	40000	40000	40000

CASH FLOW FORECASTS INCL DEBT & EQUITY



NPV (+1Yr)	**A$M**	**A$/sh.**
HPA Operations	386	$0.39
Corporate costs	-6	-$0.01
Net Cash (Debt)	26	$0.03
Total	**406**	**$0.41**

Source: Petra Capital

Investment Thesis

Altech aim to be the world's first, pure play, high purity alumina (HPA) producer. The market for all grades of HPA is expected to quadruple in size by 2025, growing from 33ktpa to 122ktpa. Demand is being propelled by fast growing high tech applications, including LEDs and lithium-ion battery separators.

Altech's proposed West Australian mine and Malaysian HPA plant will produce 4.5ktpa of HPA and generate A$180m in revenue at spot prices of US$40,000/t.

The project is significantly advanced. Development approvals are in place, ECA funding of US$190m is committed, and a fixed price EPC contract has been signed with leading German firm SMS Group that guarantees throughput volumes/quality and includes commissioning responsibility. Altech is BUY rated with a A$0.41/sh target price (1xNPV).

Separator Overview

Lithium ion battery

A lithium-ion battery is a rechargeable battery in which lithium ions travel from the negative electrode to the positive electrode during discharge and back again when charging. The battery consists of three main components;

- **Electrodes –** one negative and one positive. When discharging the positive electrode is the cathode and is typically lithium based, the negative electrode is the anode and is typically graphite based.
- **Separator –** is a thin, porous sheet, which prevents the electrodes from touching, but allows lithium ions to pass through.
- **Electrolyte –** the electrolyte or electrolytic solution provides for the movement of lithium ions, it typically consists of a lithium salt in an organic solvent.

Thermal Runaway

In this report we focus on the role and technological evolution of the separator and its importance in the safety and integrity of the battery. A battery is unique in that it contains an oxidiser (cathode) and fuel (anode/electrolyte) in a sealed container. In most other applications this combination has the risk of explosion, but in a battery, under normal operation, the anode and cathode are kept apart by a separator and convert this energy electrochemically. However, if the anode and cathode make contact, a short circuit occurs and this energy is converted directly into heat and gas. Once started, this chemical reaction will proceed to completion because of the intimate contact of fuel and oxidiser, becoming a thermal runaway. Once the thermal runaway has begun, the ability to stop it is impossible and only ceases once the fuel has expired.

Importance of Separators in XEVs

Lithium-ion batteries in XEV applications are fundamentally different to those developed for other applications;

- Scale – orders of magnitude larger than those in consumer electronics.
- Environmental conditions – exposed to a wide range of temperatures, short circuits, crushing, fire exposure, mechanical shock, and vibration.
- Performance demands – overcharge/undercharge, high rates of discharging/charging, requirements for high voltage demanding long strings of cells, long life, and high energy.

These requirements place strain on all components particularly the separator, which is required to maintain its integrity to prevent catastrophic failure of the lithium-ion battery.

Separator Technology

Manufacturing Methods

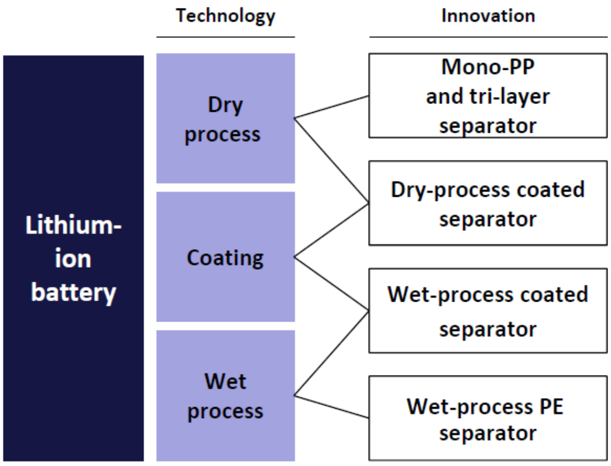
Lithium-ion battery separators (Figure 1) are polymer based porous sheets which are manufactured using one of two processing methods (Figure 2);

- **Dry Process –** The cheaper, simpler manufacturing method. The polymer, either polypropylene (PP) or polyethylene (PE) is extruded into a thin sheet, this precursor film is then annealed (cooled slowly) to improve its crystalline structure. The film is then stretched in a single direction when cold, and then stretched again when hot. The cold stretch creates pore structure whilst the hot stretch increases pore size. A porosity of 35-45% can be achieved using this method. This process can also produce a trilayer PP/PE/PP separator.
- **Wet Process –** The more expensive manufacturing method but typically produces stronger and thinner separators. Polyethylene (PE) is the polymer usually used, which is mixed with other additives to make a homogenous solution which is extruded into a thin, gel like sheet and then annealed. The sheet is stretched in two directions and exposed to a volatile solvent to remove the additives leaving a porous sheet. A porosity of 40-50% can be achieved using this method.

Figure 1: Rolls of Lithium-ion Battery Separator

Source: Company Reports

Figure 2: Asahi's Products and Manufacturing Technology Lines



Source: AsahiKASEI

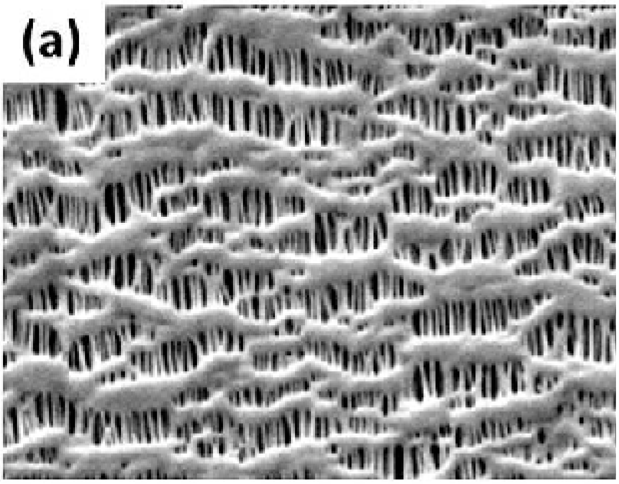
Separator Products

Monolayer Polymers

Monolayer polymers can be prepared using simple methods, at relatively low costs and are widely used as lithium-ion battery separators in a range of applications.

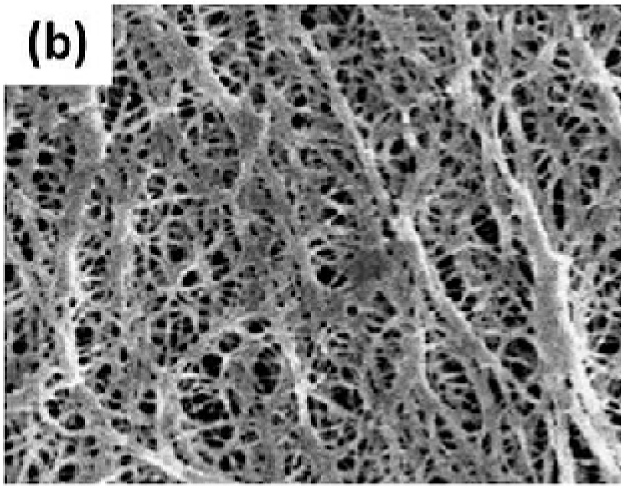
- **Monolayer PP –** A single layer of polypropylene (PP) usually manufactured using the dry production method. PP has a higher melting temperature than PE (155ºC vs 135ºC) and is cheaper to manufacture, but typically has a lower porosity. The porosity is formed from slit like pores which have a more open and straight porous structure (Figure 3). These properties make PP more suitable for high power density batteries.
- **Monolayer PE –** A single layer of polyethylene (PE) usually manufactured using the wet production method. PE has a lower melting point than PP (135ºC vs 155ºC) and is more expensive to manufacture. The interconnected pores and tortuous structure is beneficial to prevent the growth of dendrites and is better suited to long cycle life batteries (Figure 4).

Figure 3: SEM of polymer separator prepared by dry process (PP)



Source: H.Lee et al, Energy Environmental Science 2014

Figure 4: SEM of polymer separator prepared by wet process (PE)



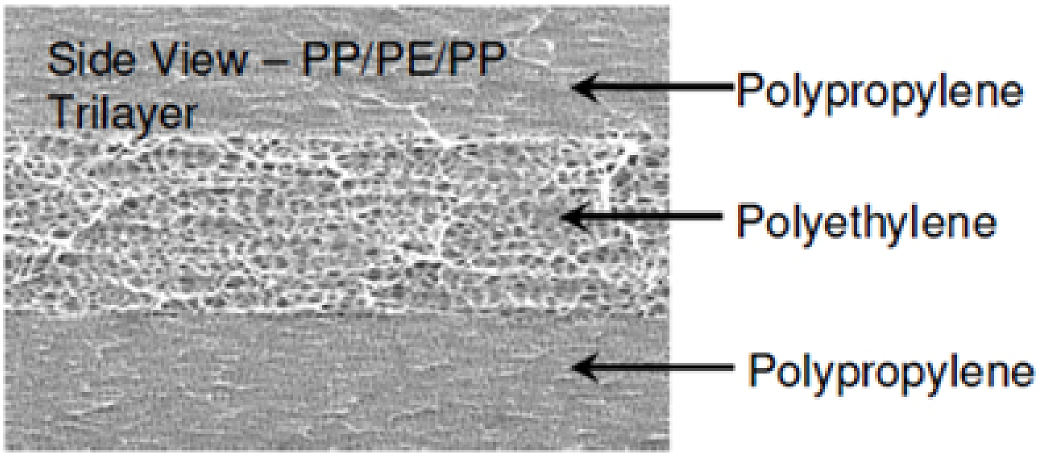
Source: H.Lee et al, Energy Environmental Science 2014

Multilayer Membranes

Monolayer polymers are simple and low cost but often struggle to achieve mechanical strength, thermal resistance, and electrochemical performance simultaneously. This has led to the development of multilayer membranes which can combine the characteristics of different polymers.

- **Trilayer PP/PE/PP –** The most common multilayer membrane. Manufactured using a uniaxial, dry-stretch process, the tri-layer of PP/PE/PP (Figure 5) combines good puncture resistance with shutdown and thermal stability. In scenarios where the cell begins to experience higher temperatures the two PP layers provide dimensional structure and mechanical strength whilst the PE layer acts as a thermal fuse. As the PE layer reaches its melting point (135ºC) the PE layer melts and closes its pore network, this blocks the pathway of ions and shuts down the battery whilst maintaining the separators integrity, preventing a thermal runaway but rendering the battery useless.

Figure 5: SEM of PP/PE/PP Trilayer separator

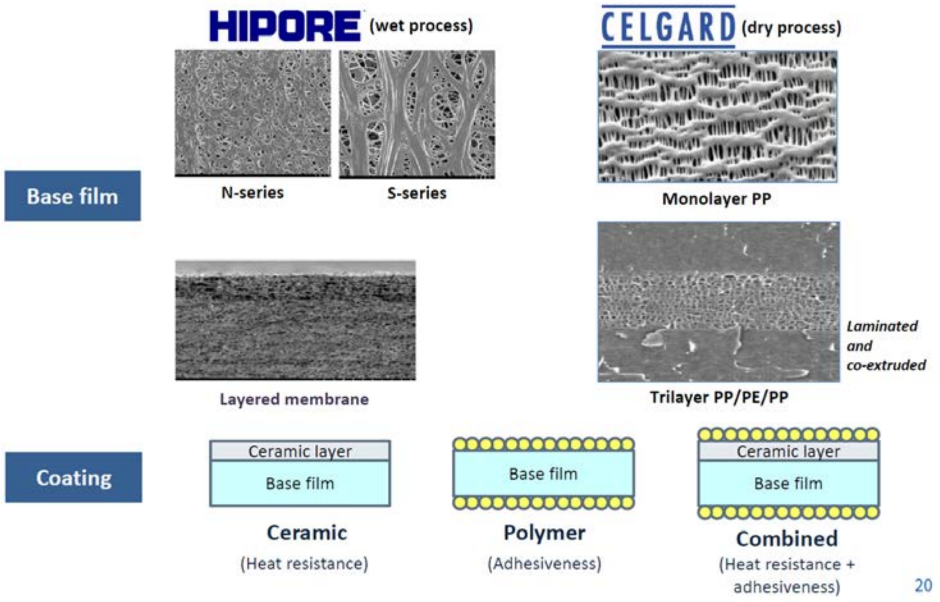


Source: Dalhousie, Handbook of Batteries

Coated Membrane Separators

Coated membranes were commercialised in c2008 in response to demand for separators that could provide safer batteries with greater short protection and better structural integrity at higher temperatures for applications in XEVs and energy storage. In general, any polymer-based membrane can be coated and benefit from the improved characteristics (Figure 6).

Figure 6: Asahi battery separator product suite

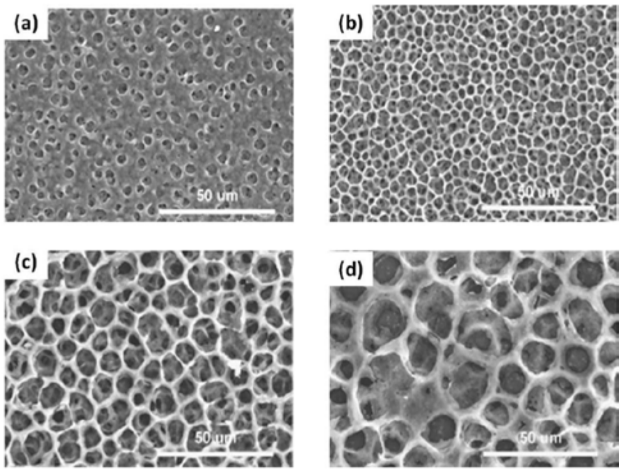


Source: AsahiKASEI

- **Dry/wet process coated –** Provides enhanced short prevention and excellent structural integrity at high temperatures. Nano sized inorganic particles such as alumina (Al_2O_3), silicon dioxide (SiO_2), titanium dioxide (Ti_2O) and aramid resin can significantly improve the mechanical strength, thermal stability and ionic conductivity of polymer membranes (Figure 7 & Figure 8). Coating the separator also increases its wettability (how easily it can be soaked by a liquid) and surface area which improves the effectiveness of the liquid electrolyte.

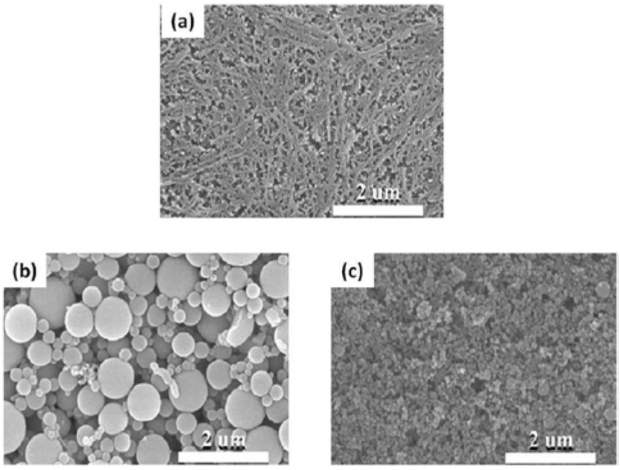
In addition to coated separators, inorganic particles can also be utilised in two other membrane types; inorganic filled membranes and inorganic particle filled non-woven mats. We understand these latter technologies are less advanced than other coated membranes.

Figure 7: Al2O3 coated PE membrane, using different concentrations of non-solvent a) 2% b) 4% c) 6% d) 8%



Source: AsahiKASEI

Figure 8: SiO2 coated PE composite with different particle sizes a) no particles b) 530nm c) 40nm



Source: AsahiKASEI

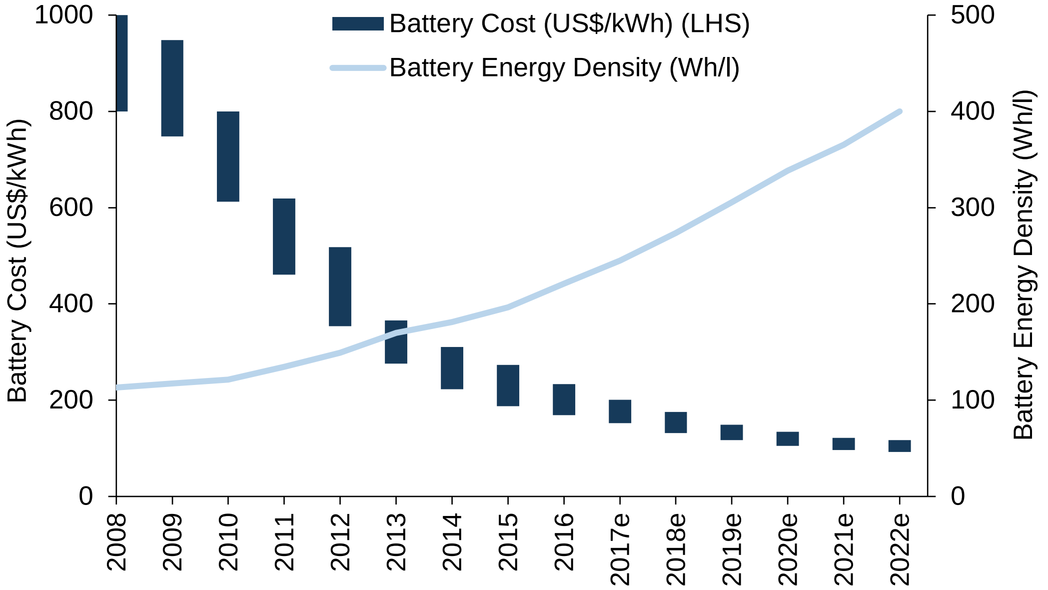
Evolution of Cathode Materials

The increased adoption of electric vehicles has had a profound effect on battery costs and energy density (Figure 9). Battery costs are falling through the economies of scale that larger battery manufacturing facilities bring to the industry, and energy density is improving as research and development continues to improve key properties of the battery.

In the future there will be a continuous focus to improve both battery costs and energy density. The improvements to energy density are likely to be achieved through changes to the battery chemistry, and particularly the cathode. Recent improvements to energy density have been achieved by increasing the nickel content (Figure 10) of the cathode.

The increased energy density increases the consequences of thermal runaway and places greater importance of the separator to keep the two electrodes apart.

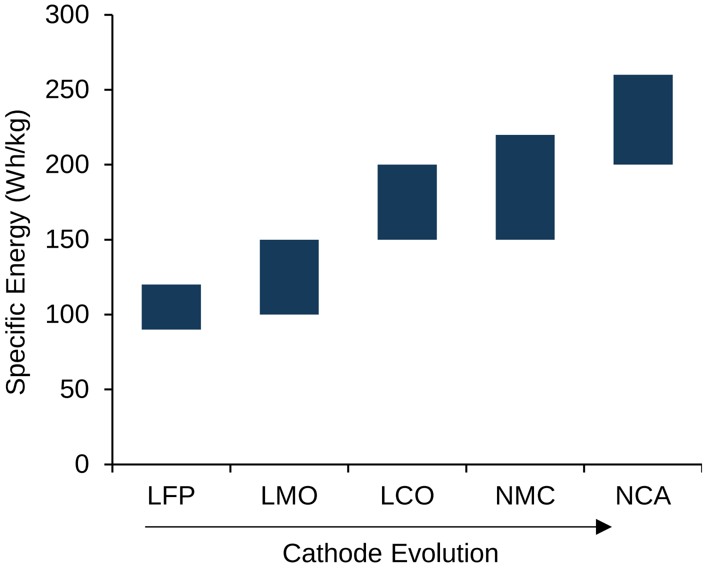
Figure 9: Battery Costs and Battery Energy Density



Source: US Department of Energy

Figure 10: Specific Energy by Cathode Type

NCA	Nickel Cobalt Aluminium
NCM	Nickel Cobalt Manganese
LCO	Lithium Cobalt Oxide
LMO	Lithium Manganese Oxide
LFP	Lithium Iron Phosphate



Source: Petra Capital

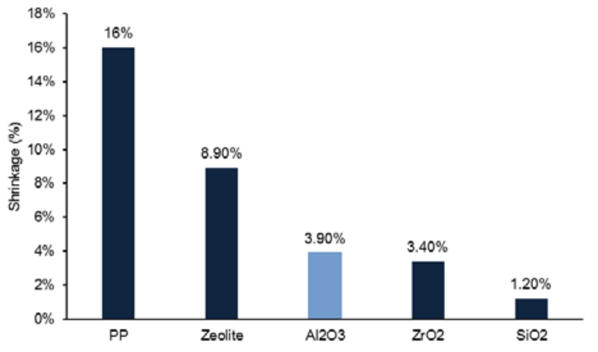
Why HPA?

It is clear that the integration of inorganic particles into polymer membranes improves the characteristics of the separator, and that HPA is the dominant inorganic particle, but there other materials that provide similar characteristics (Figure 11 to Figure 14).

Inorganic materials for battery separator manufacturing include;

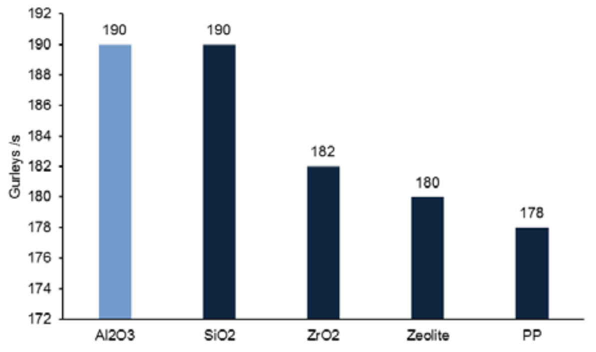
- **Al_2O_3 (HPA) –** is the incumbent and dominant inorganic particle utilised in lithium ion battery separators. It has very favourable characteristics to improve thermal stability (Figure 11) and wettability (Figure 14), and does not electrochemically react with the other battery components. In addition, the particle morphology and slurry consistencies are well understood for applying the HPA to polymer based separators.
- **SiO_2 (Silica) –** has been extensively tested and performs better than alumina in many aspects, it can show lower shrinkage and higher wettability than alumina. Despite these better physical characteristics, silica has not been adopted within inorganic separators due to the electrochemical reaction that can occur between silica and the lithium within the battery. Silica can easily become lithiated (bind with lithium) when in contact with the electrodes or the electrolyte, this consumes the lithium present in the battery and can reduce the battery life.
- **ZrO_2 (Zirconia) / Zeolite –** the development of both materials as coatings appears to be immature with no known commercial applications. Zirconia shows some positive thermal stability characteristics but apart from that, HPA and silica have better attributes.

Figure 11: Shrinkage at 130ºC for 30 mins (lower is better)



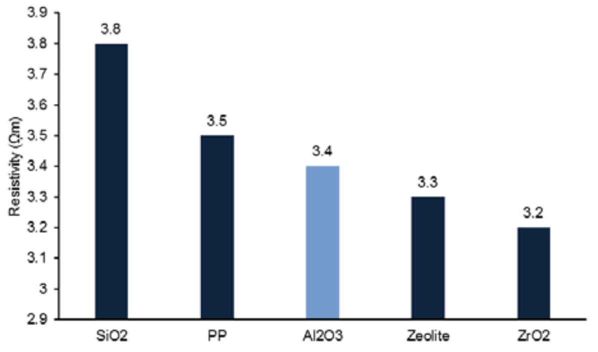
Source: Linghui et al. 2017

Figure 12: Gurley seconds (proxy for porosity, higher is better)



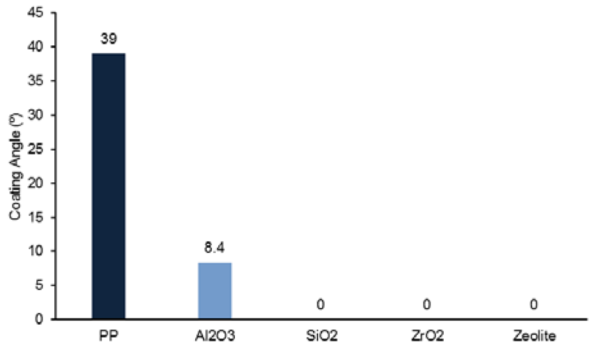
Source: Linghui et al. 2017

Figure 13: Resistivity (higher is better)



Source: Linghui et al. 2017

Figure 14: Coating Angle proxy for wettability (lower is better)



Source: Linghui et al. 2017

Manufacturers Producing Ceramic Coated Separators

Ceramic coated separators utilising HPA have been commercially adopted in both consumer electronic and XEV applications. The following leading separator manufacturers produce ceramic coated separators.

- **AsahiKasei –** 25% Mkt Share – AsahiKasei is a Japanese chemical conglomerate and became the world's largest LiBS producer following the acquisition of Polypore International in 2015.

  The group produce a range of wet (PE) and dry (PP) separators through the brands Hipore (wet) and Celgard (dry). Celgard produce several dry ceramic coated separator products which utilise HPA.
- **Toray –** 15% Mkt Share – Toray Industries is a Japanese chemical conglomerate. The group recently announced a US$1.1b capital plan to establish a European LiBS facility with capacity of 80msqm and establish a similar plant in the US. The group aims to have a global production capacity of 1.95bnsqm per year by ~2020.

  The group produce a range of wet and dry separators through the Setela brand which can be coated following the acquisition of LG Chem's South Korean LiBS ceramic coating facilities in 2016.
- **SK Innovation –** 9% Mkt Share – SK Innovation is South Korea's largest energy chemical company. The group have invested heavily in lithium-ion battery production capabilities and are suppliers to major automakers Hyundai Motor Group, BAIC Group and Daimler AG. In Dec-17 the group announced a US$920m expansion of LiBS and battery manufacturing capabilities in Europe and South Korea. In Feb-18 SK Innovation signed a 7 year offtake deal for 60ktpa $NiSO_4$ and 12ktpa $CoSO_4$ with Australian Mines (AUZ.ASX) and acquired 19.9% of the company for A$80m.

  The group produce a ceramic coated PE separator under the brand Enpass.
- **Sumitomo Chemical –** 6% Mkt Share – Sumitomo Chemicals is a Japanese chemical conglomerate. The group produce both high purity alumina in the Inorganic Materials Division and LiBS in the Battery Materials Division.

  The group produce a coated separator under the brand Pervio. Following a patent dispute settled with Polypore in 2014 (subsequently acquired by AsahiKasei) the company utilises aramid as the inorganic particle rather than high purity alumina. Pervio separators are utilised by Panasonic and car manufacturer Tesla.
- **Entek –** 4% Mkt Share – Entek is a US based battery separator manufacturer.

  The group produce a range of wet process PE separators including ceramic coated and PVDF coated PE separators for use in EV applications and large format polymer cells respectively.
- **Ube Industries –** 6% Mkt Share – Ube Industries is a Japanese chemical conglomerate. In 2011 Ube Industries formed a JV with Hitachi Maxell to produce a ceramic coated separator under the business name Ube Maxell. In 2014 Ube Maxell licenced LG Chem's Safety Reinforced Separator (SRS) technology for ceramic coated separators.

  Ube Industries has 200msqm of dry separator production capacity for the UPORE brand whilst UbeMaxell produces ceramic coated separators.
- **W-Scope –** 6% Mkt Share – W-Scope is a Japanese plastic film producer. The company has been investing heavily in coating facilities to meet growing demand from high end applications in consumer electronics and EVs.

  W-Scope produce wet separator products. In Q4'17 30% of the company's separator sales were from coated separators.

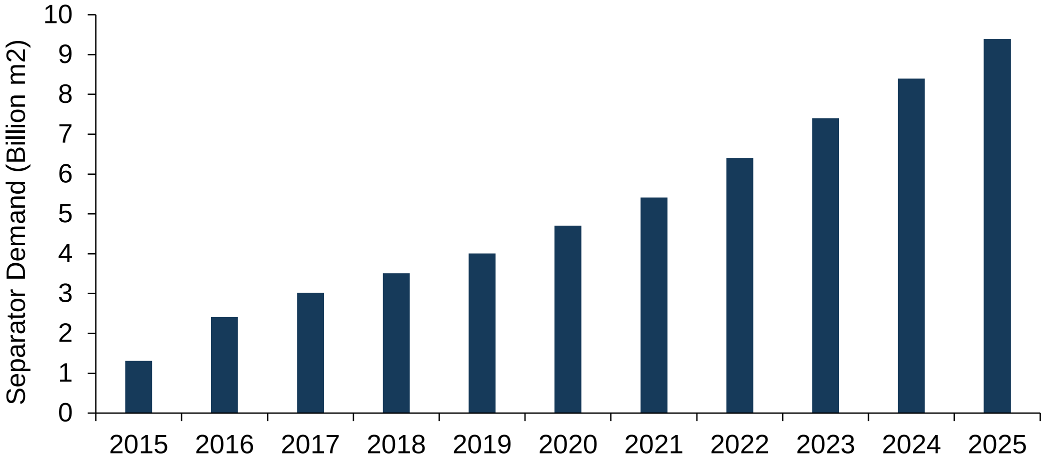
HPA Demand

The electrification of transport thematic is robust and is unquestionably placing unprecedented demand on a range of commodities. It is our view that as the energy density of batteries increases, it will make ceramic coated separators a rising necessity, placing increased demand on HPA.

Our base case assumption is for the separator market to grow to 19% of the HPA market by 2025 and by 2025 our forecasts show the separator market consuming 11.3ktpa (the equivalent of 2.5 Altech projects). This has grown from 3% of demand in 2014, to 10% of demand in 2017. Our assumptions are based on the following;

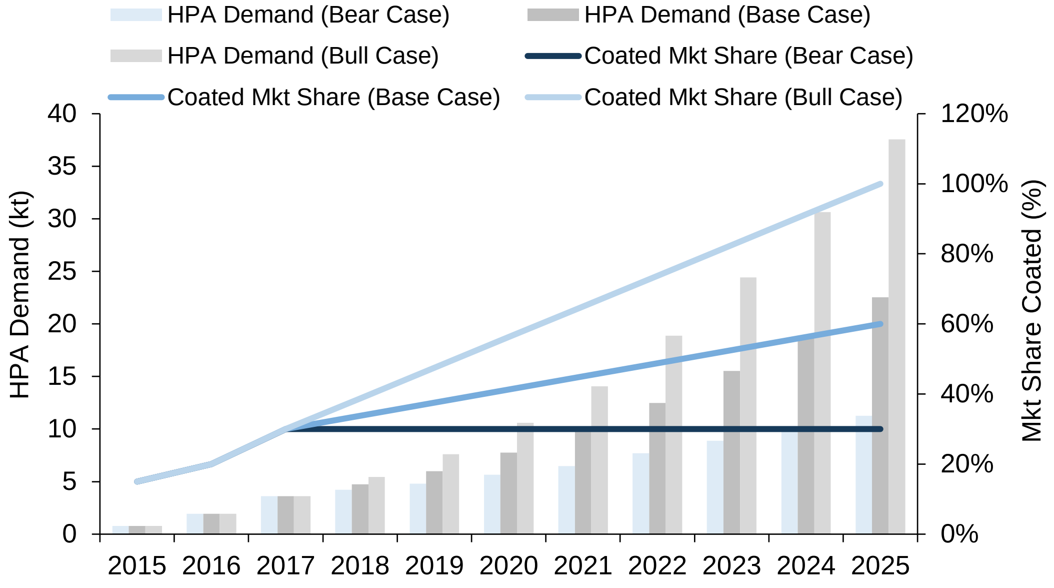
- Demand forecasts from W-Scope, a separator manufacturer (Figure 15).
- Alumina intensity of use equivalent to 4g per 1m[2].
- In our base case we assume that 60% of all separators are coated by 2025 (Figure 16) up from ~30% in 2017.
- In our bear/bull case scenarios we assume that 30%/100% respectively of all separators are coated by 2025 (Figure 16).

Figure 15: Separator Demand



Source: W-Scope

Figure 16: Demand for HPA from coated separators

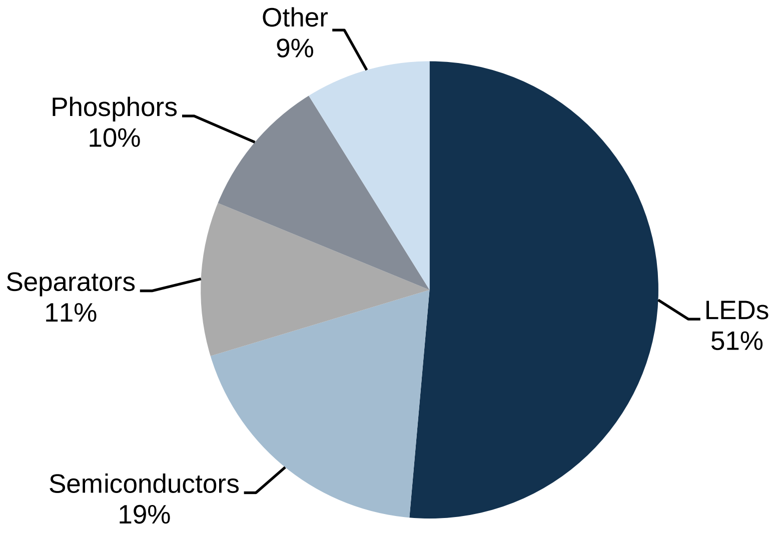


Source: Petra Capital

Overall HPA Market Dynamic

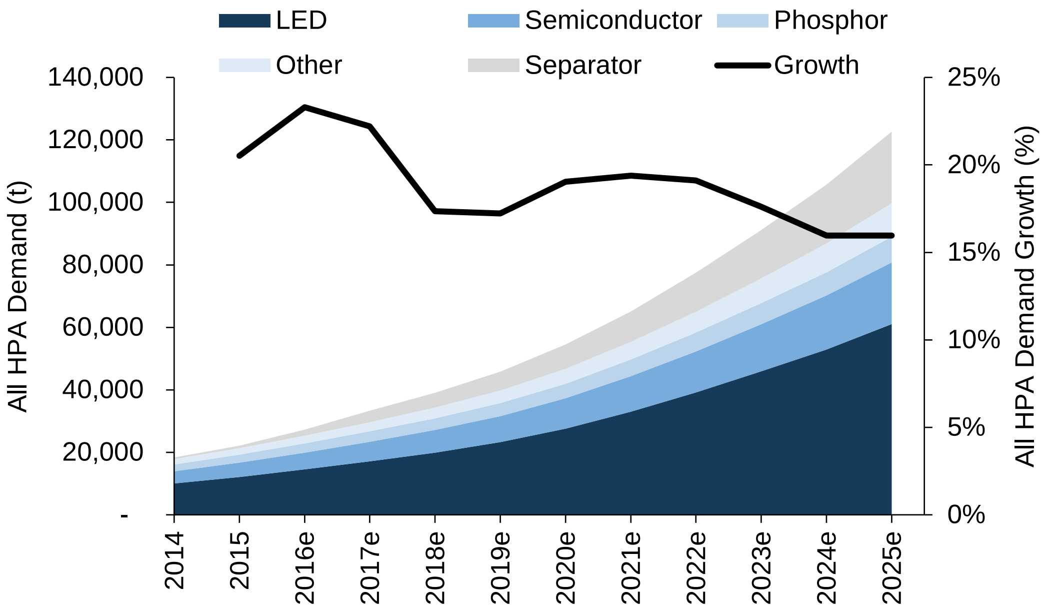
HPA is a high value, speciality product. Its principal application is as a feedstock for the production of synthetic sapphire for use in LEDs, semiconductor manufacturing and speciality glass. HPA can be used directly in the production of phosphors and has some promising emerging applications in ceramic coated separators for use in lithium ion batteries (Figure 17). Demand for all grades of HPA are expected to grow strongly at 15-20% CAGR out to 2025. This forecast growth rate is expected to drive the market from 33ktpa in 2017 to 122ktpa in 2024 (Figure 18).

Figure 17: Application of HPA (all grades) (2017e)



Source: Persistence Market Research

Figure 18: HPA (all grades) Demand Estimates



Source: Persistence Market Research

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