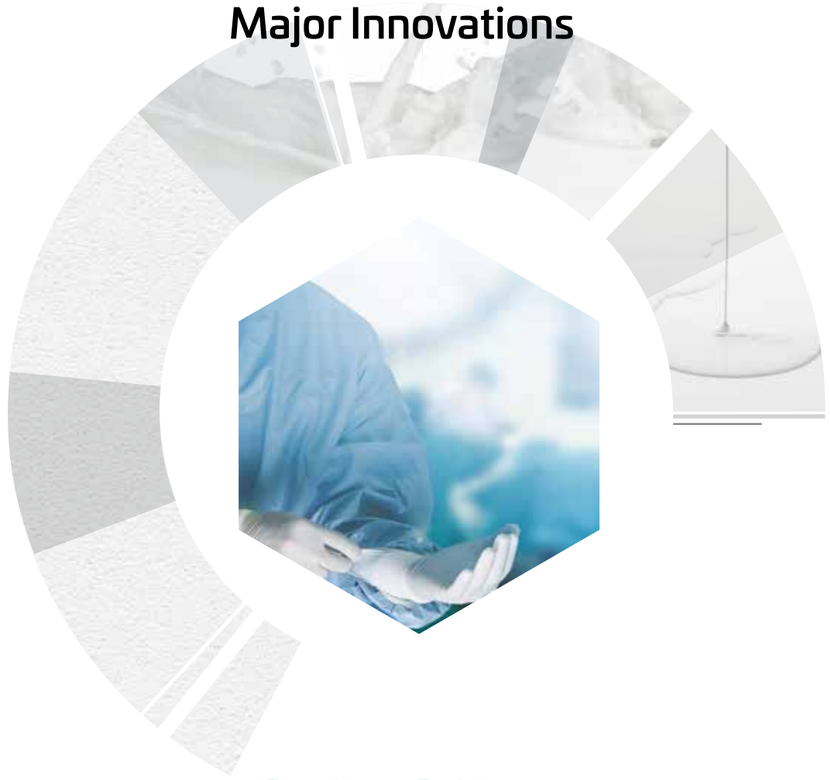
# Major Innovations



## Synthetic Rubbers

### Developed pilot technology for foam-type NBR

Foam-type acrylonitrile butadiene rubber (NBR) is a rubber foam insulation material that is used in automobiles, ships and heavy industry facilities. We have completed the development of a pilot technology for foam-type NBR, and undertaken customer evaluations. These evaluations indicate improvements in foam cell size uniformity compared to competitor products, as well as a 10-15% increase in the number of foam cells. Improvements were also made in the smoothness and tensile strength of the foam surface. Indications suggest that the inner and outer wall shapes of the foam cells are stable, and also that there are improvements in thermal conductivity and specific gravity. In addition, it has been confirmed that foam-type NBR can be used in soft products, which was not an option with general NBR products, and approval has been received for using this material in automotive parts. We have completed production of foam-type NBR for commercialization, and we are now working on quality approval from overseas customers, including in Europe and China. We will continue to put our R&BD efforts into special NBR product groups in 2018, so that we can respond quickly to customer requirements and develop pioneering products.

**Features _** Foam-type NBR

- Improvements in size uniformity and number of foam cells
- Improvements in tensile strength of foam surface and smoothness
- Can be used to produce automotive parts

### Developed and commercialized a new NB latex product for ultra-thin gloves

Most glove manufacturers have been aiming to manufacture an ultra-lightweight glove which weighs less than 3.0g, in order to differentiate quality and improve price competitiveness. Ultra-lightweight gloves have to satisfy one particular essential requirement, which is force-at-break of no less than 6N. Latex manufacturers have released various new products with increased tensile strength, but only one product has satisfied this criterion so far. However, backed by our outstanding technological know-how in NB latex, in late 2017 KKPC launched ‘KNL 834’, a new product with a more than a 10% improvement in tensile strength over our existing latex product KNL 830. Thanks to its high tensile strength and stability, KNL 834 can be used easily under various production conditions of a wide range of customers. KNL 834 is also getting good reviews from customers for its extremely low defect rate. Supported by our new product development, we will win new customers and improve productivity while increasing sales and profitability by developing distinctive product competitiveness.

**Features _** KNL 834

- High tensile strength and stability
- Low defect rate



More information is available on our website

## Synthetic Resins

### Improved product competitiveness through HIPS catalytic polymerization

Polystyrene (PS) is mostly manufactured by thermal polymerization. KKPC, however, has developed a manufacturing technology that combines our unique continuous process control with catalytic polymerization technology to create catalytic polymerization. This manufacturing technology upgrades both cost and quality competitiveness, with cost reductions being achieved in both special and general grades. In addition, the manufacturing of highly functional products has become easier thanks to our polymerization technology, which uses a multi-functional catalyst. We are also establishing the basis for the production of plastic materials which are suitable for eco-friendly food containers by reducing the weight of oligomers. Moreover, we plan to continue related research to improve cost competitiveness.

**Features _** HIPS catalytic polymerization manufacturing technology

- Improvements in cost competitiveness
- Improvements in quality competitiveness
- Easier production of highly functional products

### Enhanced CPP productivity by applying high solid technology

Copolymer polyol (CPP) is a product used for strengthening the hardness of urethane foam, and there have been active R&D activities to develop a low-viscosity high solid CPP polymerization technology which can manufacture CPP products with high styrene acrylonitrile (SAN) content at low viscosity. KKPC has completed the development of a manufacturing process that can effectively produce low-viscosity high solid CPP by leveraging our exclusive technology. We also became the first company in Korea to successfully commercialize ‘CS850’, a product with a solid content as high as 49%. In addition, we are expanding the application of our high solid technology to commodity CPP products, which has resulted in increased productivity and quality. We are now aiming to lead the CPP market at home and abroad by further enhancing quality and actively increasing sales of low-viscosity high solid CPP products.

**Features _** High solid CPP polymerization technology

- Enhanced efficiency in producing the low-viscosity high solid CPP product
- Improved productivity and quality of commodity CPP products

# Electronic Materials

### Developed KrF thick PR for 3D NAND flash memory

Although NAND flash memory manufacturing is structurally simple, volatile pricing has prevented it from gaining much traction in the semiconductor market. However, the recent development of 3D NAND flash memory, which can increase the degree of integration per unit area, has boosted margins compared to manufacturing costs, depending on the number of layers. As a result, all photoresist (PR) manufacturers in Korea and overseas are focusing on developing KrF thick PR for 3D NAND flash memory, which can increase the number of layers. In 2017, we acquired the basic properties needed for the development of KrF thick PR for 3D NAND flash memory, in our efforts to satisfy the performance requirements of our domestic and overseas customers. As of the end of 2017, we have satisfied the performance requirements for one layer each for a Korean and a Chinese semiconductor company, and we are now working on meeting the requirements for additional processes.

**Features _** KrF thick PR for 3D NAND flash memory

Used for 3D NAND flash memory

Easy to be used in layer structure

### Developed a new ArF immersion BARC product

Bottom anti-reflection coating (BARC) is a polymer coating that is used on the lower layer of PR to control light reflectivity, which enables higher resolution. We succeeded in the mass production of an ArF immersion BARC product in 2015 and sell it. Based on this technology, we have developed a new ArF immersion BARC product that has a higher refractive index and better etching performance than the existing product, and we are awaiting customer evaluation. Our future plan is to develop product groups that are applicable to next-generation semiconductor processes. In particular, we have been targeting the growing semiconductor market in China by developing product groups especially for the local market, including ArF Dry BARC and KrF BARC, and we are now moving forward with customer evaluations.

**Features _** ArF Immersion BARC

High refractive index

High etching performance



# 16 World-class Products

### Styrene butadiene rubber (SBR)

This synthetic rubber product is manufactured by the emulsion polymerization of styrene and butadiene at low temperature. SBR delivers more consistent quality, as well as excellent heat and wear resistance, when compared with natural rubber, and is widely used as a feedstock for tires, shoes and industrial goods.

### High-cis polybutadiene rubber (HBR)

HBR is manufactured through the solution polymerization of 1,3-butadiene. With more than 96% cis content, it has outstanding wear resistance, rebound resilience, aging resistance and water resistance. Its glass transition temperature (Tg) is very low, at around -100℃, which means it is a widely used synthetic rubber product.

### Acrylonitrile butadiene rubber (NBR)

This copolymer is manufactured by emulsion-polymerizing acrylonitrile and butadiene at low temperatures. NBR is a synthetic rubber product with excellent oil and chemical resistance, and is easy to process due to its good usability, including roll-winding, mixing dispersibility, and extrudability, and its proper vulcanization characteristics.

### Low-cis polybutadiene rubber (LBR)

LBR is manufactured by using lithium catalysts. It features a cis content of 34.5%, good elasticity, and a vinyl bonding structure of around 14.5%, all of which combine to offer good reactivity. It is mainly used as a base polymer in manufacturing high impact polystyrene (HIPS).

### Acrylonitrile butadiene latex (NB Latex)

This carboxy-modified acrylonitrile butadiene latex is used for making latex gloves, including for medical purposes, and abrasive paper. It is replacing natural latex, and the market is growing sharply thanks to its durability, wear resistance, high tensile strength and outstanding color hold.

### KSL-341 foam latex

This styrene-butadiene latex is used for foam rubber. Compared with other latex, it has high density, low flow and outstanding stability, which is why it can be used on its own to manufacture foam rubber. It is used for mattresses, shoes, cosmetic powder puffs and impact resistance reinforcing agents for various plastics.

### Ethylene propylene diene monomer (EPDM)

This amorphous polymer material is manufactured through the copolymerization of ethylene and propylene. It delivers outstanding heat resistance, ozone resistance, insulation characteristics and a low specific gravity, making it perfect for lightweight materials. Because of its stable chemical characteristics, it is used for a wide variety of purposes, including in automobiles, electricity and electronics, as well as general industrial goods.

### KUMANOX 13 antioxidant

This commodity antioxidant enables basic attributes of a product to be maintained, such as ozone resistance, flexibility resistance, oxidation resistance and cracking prevention. Because of its coloration and staining characteristics, it is widely used in rubber, tires and belts.

### KUMANOX 5010L antioxidant

This high-performance phenolic antioxidant delivers outstanding discoloration and coloration-prevention. It is a non-staining antioxidant with low volatility, and offers both high quality and excellent price competitiveness. It is used for a wide range of purposes, including tires, belts and medical gloves.

### Phenolic additives (PA)

This fine chemical product is added to polymers such as rubber, resin and paint, in order to maintain their performance for a longer period of use or a wider temperature range, and thus improve their unique properties. It prevents oxidation of the double bonds of rubber and improves the viscosity of resin and paints, which improves processing quality and reduces processing time.

### Methyl isobutyl ketone (MIBK)

MIBK is made through an acetone and hydrogen reaction using a catalyst. This colorless, transparent liquid is flammable and has an unusual odor. It is used as a feedstock for vinyl, acryl, alkyd, polyester, epoxy resin solvents and various chemical reactions.

### Bisphenol-A (BPA)

This white crystalline solid is created through a condensation reaction between phenol and acetone, in the presence of a catalyst. It is used as a feedstock for polycarbonate, phenolic, polyester and other resins, and is used in automobiles, electricity and electronics, as well as IT industries.

### Phenol*

Cumene is used as the feedstock to manufacture this colorless raphide or white crystalline aggregate with a unique odor. It is used as a feedstock for phenolic resin, BPA, caprolactam, alkylphenol, adipic acid and plasticizer, and is used in automobiles, electricity and electronics, as well as IT industries.

### Aceton*

Aceton is manufactured using cumene as its feedstock, and is co-produced with phenol. This colorless liquid has a unique odor, and is flammable with a low boiling point. It is used as a feedstock for MIBK, BPA and methyl acrylate, and in the manufacture of a wide range of coatings and plastics.

### Polymethylene polyphenylisocyanate*

This material is obtained by the phosgene treatment of diphenylmethane diamine, created through the condensation of aniline and formaldehyde. It is in liquid form at room temperature, and is used in a range of products, including hard foam, semi-hard foam and CASE.

### Diphenylmethane-4,4,diisocyanate*

This pure monomeric MDI is the result of high-purity refinement. It is in white solid form at room temperature, and has water-like transparency in liquid form. It features outstanding discoloration resistance against high temperatures and UV rays, and is used in spandex fibers and TPU.

* Newly selected in 2017