Merck KGaA
Darmstadt, Germany

News Release

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Merck KGaA, Darmstadt, Germany, Enables Innovations in the Electronics Industry

- **Consumer Electronics Show (CES) in Las Vegas is the stage for new innovations in the electronics industry**
- **As a leading player in this sector, Merck KGaA, Darmstadt, Germany, is creating innovations for computer chips and displays**
- **Merck KGaA, Darmstadt, Germany, offers journalists the opportunity during the week starting December 10 to learn more about new technologies such as Directed Self-Assembly (DSA) technology, foldable displays and liquid crystal windows**

Darmstadt, Germany, December 6, 2018 – Merck KGaA, Darmstadt, Germany, a leading science and technology company, today announced that it will be exhibiting at the Consumer Electronics Show (CES), one of the world's largest consumer technology exhibitions, from January 8 to 11, 2019 in Las Vegas, Nevada. Likewise, the company will take part in the Pepcom Digital Experience event in Las Vegas on January 7, 2019.

The Performance Materials business sector comprises the specialty chemicals business of Merck KGaA, Darmstadt, Germany, and supplies solutions for displays, computer chips, and surfaces of every kind. The business sector, which plays a leading role in the electronics market, will be showcasing its technologies at the CES in Las Vegas. Every year, new products and innovations for the electronics sector are presented there.

"Megatrends such as digitalization, urbanization and mobility are drivers of innovation in the field of modern electronic systems. Our high-tech solutions make

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the realization of Artificial Intelligence, Big Data, 5G, the Internet of Things, and autonomous driving possible," said Kai Beckmann, CEO Performance Materials and member of the Executive Board of Merck KGaA, Darmstadt, Germany. "The need for faster computing power and greater memory capacity is set to grow more rapidly than ever before."

Innovations for the semiconductor industry

The challenge facing the semiconductor industry is to develop more and more powerful processors and larger memory chips that simultaneously meet energy efficiency and cost targets. With its solutions, Merck KGaA, Darmstadt, Germany, is playing a key role in making computer chips even smaller and cheaper while enhancing their functionality and computing power at the same time. For instance, integrated circuits the size of a postage stamp can accommodate nearly as many transistors as there are people on earth today – around seven billion. Yet further miniaturization of the structures used on semiconductors is slowly reaching physical limits. That is why today memory chips are not only using the limited two-dimensional surface area, but are also being structured in a third dimension. 3D NAND technology permits the development of stacked chip architecture, which can be manufactured using materials from Merck KGaA, Darmstadt, Germany. "When comparing the ratio between the surface area and the height of a 3D NAND chip with a skyscraper, we are already reaching the dimension three times the world's tallest building, and soon ten times the height of a Burj Khalifa will be achieved, which at 830 meters is currently the world's tallest building," explained Anand Nambiar, Head of the Semiconductor Solutions business unit within the Performance Materials business sector. "Our deposition, patterning and spin-on dielectric materials make this technology possible in the first place. We are currently working with our customers on new 3D NAND architectures that will enable memory chips to operate twice as fast while reducing cost and significantly cutting energy requirements."

A further breakthrough innovation in the semiconductor industry is a chemical-based solution using block co-polymers that cause the materials to self-assemble and move into pre-defined patterns. Today, owing to Directed Self-Assembly (DSA) technology, very narrow, conductive pattern structures in the 10 nanometer range are already possible today. When compared with conventional multiple image

patterning technology, which is far more work-intensive and cost-prohibitive, DSA has the great advantage of permitting high-volume cost-effective nanoscale manufacturing. Multiple semiconductor companies are piloting this technology for high volume manufacturing. “This revolutionary technology from Merck KGaA, Darmstadt, Germany, is expected to completely change the semiconductor manufacturing process and will accelerate the introduction of next generation patterning applications,” says Anand Nambiar.

Innovations for the Display Industry

With its liquid crystals business, Merck KGaA, Darmstadt, Germany, is the leading producer of liquid crystal mixtures for the display industry. At the same time, the Organic Light Emitting Diode (OLED) technology, for which Merck KGaA, Darmstadt, Germany, also ranks among the leading material suppliers, is gaining importance in the high-end display sector. Foldable or bendable smartphone displays are one application of OLED materials currently coming onto the market. “Our OLED materials permit flexible and foldable display applications combined with reflection protection and better image quality thanks to novel reactive mesogens. OLED displays are also particularly interesting for mobile end devices because their thin design leaves more room for batteries, thus making it possible to increase battery life by more than 10%,” explains Michael Heckmeier, Head of the Display Solutions business unit within Performance Materials.

Merck KGaA, Darmstadt, Germany, is pursuing a strategy of leveraging its expertise as the global market leader in liquid crystals in order to develop new fields of application for innovative liquid crystal technologies. Liquid crystal window modules, which became commercially available this year, are an innovation in the architectural sector. At the push of a button, the light transmittance of the windows can be changed while remaining transparent. This creates a pleasant indoor ambiance without blocking wide views. “When our technology is used, buildings become more sustainable and energy-efficient. The window modules are available in a wide range of colors and shapes, giving architects extensive design freedom,” Michael Heckmeier underscores. Initial projects are already underway. For example, a project by the world-renowned architect Oscar Niemeyer is currently being realized at the headquarters of Kirow, a company based in Leipzig, Germany. In

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addition, the first complete glass façade with this technology is being constructed at the FC Group in Karlsruhe, Germany.

We invite interested journalists to contact us at the CES or at the Pepcom Digital Experience event in Las Vegas.

Please get in touch with us. Meagan Kane (meagan.kane@emdgroup.com) will be happy to arrange a meeting with you.

Additionally, we invite you to technology background briefings with Anand Nambiar and Michael Heckmeier on December 10, at 9 a.m. (EST)

To access via webcast click here: webcast link, alternative dial in number can be accessed here. Access code is 35906217#.

About Merck KGaA, Darmstadt, Germany
Merck KGaA, Darmstadt, Germany, the vibrant science and technology company, operates across healthcare, life science and performance materials. Around 51,000 employees work to make a positive difference to millions of people's lives every day by creating more joyful and sustainable ways to live. From advancing gene editing technologies and discovering unique ways to treat the most challenging diseases to enabling the intelligence of devices – the company is everywhere. In 2017, Merck KGaA, Darmstadt, Germany, generated sales of € 15.3 billion in 66 countries.

The company holds the global rights to the name and trademark "Merck" internationally. The only exceptions are the United States and Canada, where the business sectors of Merck KGaA, Darmstadt, Germany operate as EMD Serono in healthcare, MilliporeSigma in life science, and EMD Performance Materials. Since its founding 1668, scientific exploration and responsible entrepreneurship have been key to the company's technological and scientific advances. To this day, the founding family remains the majority owner of the publicly listed company. For more information about Merck, KGaA, Darmstadt, Germany, visit www.emdgroup.com.