



CARL ZEISS SMT GMBH AND CARL ZEISS OBERKOCHEN GRUNDSTÜCKS GMBH & CO. KG

EUV optics systems for lithography with sub-10nm resolution

Carl Zeiss develops, produces and sells optical devices for lithography using EUV light (EUV = extreme ultra violet) to expose semiconductor wafers with the smallest structures. Carl Zeiss SMT, based in Oberkochen, Germany, is part of Carl Zeiss AG and is a global company with more than 4,000 employees and a supplier to the semiconductor industry. Other subsidiaries are located in Jena, Roßdorf and Wetzlar, as well as in Bar Lev (Israel), Peabody and Pleasanton (USA). The product portfolio in terms of equipment for the manufacture of extremely high-performance microchips includes imaging and illumination systems for semiconductor production, photomask solutions and solutions for process control and error analysis.

Challenges

Modern communication, automotive and industrial applications place high demands on the performance of the microelectronics used. The essential basis for this are high-performance, energy-efficient microchips with the smallest integrated circuits (IC). For a long time, the semiconductor industry has

been following Moore's Law, according to which the integration density of ICs produced by lithography regularly doubles. Up to now, these microchips have mainly been manufactured using optical lithography with light at a wavelength of 193 nm. To realise structure sizes below 10 nanometres, extreme ultraviolet light (EUV) must be used instead: This enables a significantly better optical resolution. However, EUV lithography entails a number of challenges. EUV light is strongly absorbed, so exposure must take place in a vacuum, and refractive optics with lenses must be replaced by reflective optics with mirrors in the illumination and imaging systems. The demands on the optics to be developed are great: they require a high level of research and development in order to significantly improve the surface quality, material composition, size and shape.

Objective

With considerable research and development effort, Carl Zeiss will set up a production line for the manufacture of a new generation of high-performance EUV

projection optics. A significantly enlarged numerical aperture will make it possible to resolve structures below 10 nm. This will include production facilities for grinding, lapping and polishing the mirror surfaces, for ion beam fine machining, for coating the fine reflection and protective layers as well as facilities for measuring the mirror surface. Furthermore, a production line for the production of the novel illumination system matched to the imaging optics must be set up. In future, these projection optics will be used to create the smallest nanometre structures and to produce the most modern semiconductor chips. In the future, it will be used worldwide for products in the communications industry, automotive and medical technology, Industrie 4.0 and for the Internet of Things.

Approaches

In the project, Carl Zeiss will develop a completely new type of optics technology and introduce it in the field of semiconductor production. This will enable impairments in image quality to be overcome and the performance of the



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optics to be increased to such an extent that structures significantly smaller than 10 nm can be optically produced in the future. New innovative components and manufacturing processes must be developed to produce these optical components. In addition to technologies for surface shaping and coating, metrological systems are needed to evaluate and monitor the quality of the optical components. Size, weight and the required surface precision are well above the current state of the art and require intensive research and development work.

Perspectives

In order to disseminate the results and transfer knowledge, cooperation with universities and research institutions as well as participation in symposia and conferences are planned. This promotes the practice-relevant training of young scientists. The Carl Zeiss network for lithographic optics in Europe comprises more than 500 companies, many of them SMEs, which can participate in the economic success of Carl Zeiss through development and production orders. The production of state-of-the-art, high-performance, energy-saving microchips is

already virtually impossible without the imaging and illumination system developed by Carl Zeiss. Even smaller structures can only be realised with the EUV optics developed in the Carl Zeiss project.

Through this project, Carl Zeiss can strengthen business areas, create new jobs in Germany and secure existing ones. With the development of novel optical systems for semiconductor-based microelectronics production, the project contributes to advancing the key technology of micro- and nanoelectronics as a common European goal.

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