



# Nanolithography: Techniques are used in Nanolithography

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## ABSTRACT

Nanolithography is the process of creating nanoscale patterns or structures on a substrate using various techniques such as electron beam lithography, scanning probe microscopy, and nanoimprint lithography. It has become an important tool in nanotechnology research and development due to its ability to fabricate complex structures with precise control over feature size, shape, and placement. Electron beam lithography (EBL) is one of the most commonly used techniques in nanolithography. It involves the use of a focused beam of electrons to create patterns on a substrate coated with a resist material. The resist material is selectively exposed to the electron beam, which causes a chemical change that allows for the creation of high-resolution patterns with feature sizes as small as a few nanometers. Scanning probe microscopy (SPM) is another popular technique in nanolithography. It involves the use of a sharp tip, such as an atomic force microscope (AFM) or a scanning tunneling microscope (STM), to directly pattern a substrate surface by scanning the tip across the surface. SPM has the advantage of being able to pattern surfaces that are not flat or uniform, and can create patterns with resolutions down to a few atoms.

Nanoimprint lithography (NIL) is a relatively new technique that involves the use of a mold to transfer a pattern onto a substrate. The mold is typically made using EBL or SPM and is used to press a resist material onto the substrate to create the desired pattern. NIL has the advantage of being able to produce large-scale patterns with high resolution and has potential for mass production. Nanolithography has numerous applications in various fields such as microelectronics, photonics, and biotechnology. In microelectronics, nanolithography is used to fabricate nanoscale features on semiconductor substrates for the production of microchips and other electronic devices. In photonics, nanolithography is used to create photonic structures such as waveguides and gratings for optical communication and sensing applications. In biotechnology, nanolithography is used to create patterns and structures for cell manipulation and tissue engineering.

**Keywords:** Nanolithography; Electron beam lithography; Scanning tunneling microscope; Nanoimprint lithography; Biotechnology; Tissue engineering; Electron beam lithography; Microelectronics

## INTRODUCTION

Nanolithography is a rapidly evolving field of science and technology that deals with the creation of nanostructures with extremely small dimensions, typically less than 100 nanometers in size. The term "nanolithography" is derived from two words - "nano" meaning small or tiny and "lithography" meaning the process of creating patterns on a surface [1]. In essence, nanolithography is a technique used to fabricate structures on a nanometer scale. It has found applications in a wide range of fields, including electronics, photonics, biotechnology, and medicine. The ability to create such small structures is critical in the development of next-generation devices, such as high-performance computer chips, nanosensors, and advanced drug delivery systems. Nanolithography involves the use of a variety of techniques, each with its own strengths and limitations. These techniques can be broadly classified into two

categories: top-down and bottom-up [2].

Top-down techniques involve the use of larger structures or materials to create smaller structures. For example, photolithography, a widely used top-down technique, uses light to create patterns on a substrate by selectively exposing certain areas to light and then etching away the unexposed areas [3]. This process can create patterns with extremely small dimensions but has limitations in terms of resolution and the types of materials that can be used. Bottom-up techniques, on the other hand, involve the assembly of smaller structures to form larger structures. For example, self-assembly techniques use chemical or physical forces to guide the assembly of small building blocks into larger structures. This process has the advantage of creating structures with precise control over size, shape, and composition but can be more challenging to implement [4].

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Nanolithography has advanced rapidly in recent years, with new techniques and materials being developed at an ever-increasing rate. As a result, it is playing an increasingly important role in the development of advanced technologies and is expected to continue to do so in the future.

### Techniques are used in nanolithography

Nanolithography is a branch of nanotechnology that deals with the fabrication of structures with dimensions in the range of a few nanometers or less. It involves the use of various techniques to create patterns or structures on a substrate, typically a silicon wafer or a polymer film, at the nanoscale level [5]. The resulting structures can be used for a wide range of applications, such as nanoelectronics, nanophotonics, and nanobiotechnology. The need for nanolithography arises from the limitations of conventional lithography techniques that are used to fabricate structures with dimensions in the micrometer range. The minimum feature size that can be achieved by conventional lithography is limited by the wavelength of the light used to expose the photoresist. The current state-of-the-art techniques, such as deep ultraviolet lithography, can achieve feature sizes of around 10 nanometers. However, for many applications, such as nanoelectronics, even smaller feature sizes are required [6].

There are several techniques that are used in nanolithography, each with its own advantages and limitations. Some of the commonly used techniques are:

#### Electron Beam Lithography (EBL)

In EBL, a focused beam of electrons is used to expose a resist material on a substrate. The electron beam can be precisely controlled to create patterns with high resolution, down to a few nanometers. However, the process is slow and expensive, and is typically used for prototyping or low-volume production [7].

#### Scanning Probe Lithography (SPL)

SPL uses a sharp tip, such as an atomic force microscope (AFM) tip, to create patterns on a substrate by either mechanical or chemical means. The technique can achieve feature sizes down to a few nanometers and is relatively simple and inexpensive. However, the process is slow and cannot be used for high-volume production. Nanoimprint Lithography (NIL): In NIL, a mold with nanoscale features is pressed onto a resist-coated substrate to create a pattern. The process is fast and can achieve high resolution, down to a few nanometers [8]. However, the mold fabrication can be expensive, and the process is limited by the size and shape of the mold.

#### Dip-Pen Nanolithography (DPN)

DPN uses a sharp tip, such as an AFM tip, to deposit a resist material on a substrate to create patterns. The process is relatively simple and can achieve high resolution, down to a few nanometers. However, the process is slow and cannot be used for high-volume production [9].

#### Extreme Ultraviolet Lithography (EUVL)

EUVL uses a high-energy beam of ultraviolet light with a wavelength of around 13.5 nanometers to expose a resist material on a substrate. The process is fast and can achieve high resolution, down to a few nanometers. However, the technology is expensive and requires a complex set-up.

In addition to these techniques, there are several other emerging techniques, such as block copolymer lithography, nanoimprint lithography with a soft stamp, and DNA origami lithography, that offer unique advantages and limitations for specific applications [10]. The applications of nanolithography are diverse and range from nanoelectronics to nanophotonics to nanobiotechnology. In nanoelectronics, nanolithography is used to create transistors, memory devices, and interconnects with dimensions in the nanometer range, leading to faster and more efficient devices. In nanophotonics, nanolithography is used to create photonic crystals, waveguides, and plasmonic structures, enabling the manipulation of light at the nanoscale level. In nanobiotechnology, nanolithography is used to create patterns of biomolecules, such as proteins and DNA.

## CONCLUSION

Nanolithography is a powerful tool for creating nanoscale structures with precise control and accuracy. It has a wide range of applications in various fields, including electronics, photonics, medicine, and biology. The various nanolithography techniques, such as electron beam lithography, photolithography, and nanoimprint lithography, have their strengths and limitations, and the choice of technique depends on the specific requirements of the application. With the rapid development of nanotechnology, nanolithography will continue to play a critical role in advancing our understanding of the nanoscale world and driving the development of new technologies. However, it also raises concerns about potential environmental and health impacts, and it is important to carefully consider and mitigate these risks as we continue to push the boundaries of nanoscale engineering.

Nanolithography is a powerful tool for creating nanoscale patterns and structures with high precision and resolution. It has a wide range of applications in various fields and is continually being developed and improved to push the limits of nanofabrication technology.

## REFERENCES

1. Opara KN, Udoidung NI, Opara DC, Okon OE, Edosomwan EU, Udoh AJ, et al. The impact of intestinal parasitic infections on the nutritional status of rural and urban school-aged children in Nigeria. *Int J MCH AIDS*. 2012;1(1):73.
2. Opara KN, Udoidung NI, Opara DC, Okon OE, Edosomwan EU, Udoh AJ, et al. The impact of intestinal parasitic infections on the nutritional status of rural and urban school-aged children in Nigeria. *Int J MCH AIDS*. 2012;1(1):73.
3. Levecke B, Montresor A, Albonico M, Ame SM, Behnke JM, Bethony JM, et al. Assessment of anthelmintic efficacy of mebendazole in school children in six countries where soil-transmitted helminths are endemic. *PLoS Negl Trop Dis*. 2014;8(10):e3204.
4. Gabrielli AF, Montresor A, Chitsulo L, Engels D, Savioli L. Preventive chemotherapy in human helminthiasis: theoretical and operational aspects. *Trans R Soc Trop Med Hyg*. 2011;105(12):683-693.
5. Shatkin JA, Ong KJ. Alternative Testing Strategies for Nanomaterials: State of the Science and Considerations for Risk Analysis. *Risk Anal*. 2016; 36(8):1564-1580.
6. Cristina Buzea, Ivan Pacheco, Kevin Robbie. Nanomaterials and Nanoparticles: Sources and Toxicity. *Biointerphases*. 2007;2(4):17-71.
7. Smith DR, Padilla WJ, Vier DC, Nemat-Nasser SC, Schultz S. Composite Medium with Simultaneously Negative Permeability and Permittivity. *Physical Review Letters*. 2000;84(18): 4184-7.

8. Allison John, Backman Dan, Christodoulou Leo. Integrated computational materials engineering: A new paradigm for the global materials profession. JOM. 2006;58(11): 25-27.
9. Warren James A, Ward CH. Evolution of a Materials Data Infrastructure. JOM. 2018;70(9): 1652-1658.
10. Curtarolo Stefano, Hart Gus LW, Nardelli MB, Sanvito S, Levy Ohad. The high-throughput highway to computational materials design. Nature Materials. 2013;12(3): 191-201.