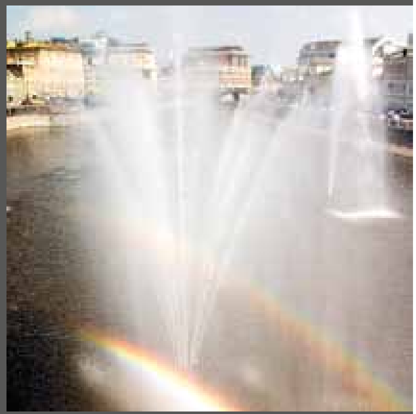
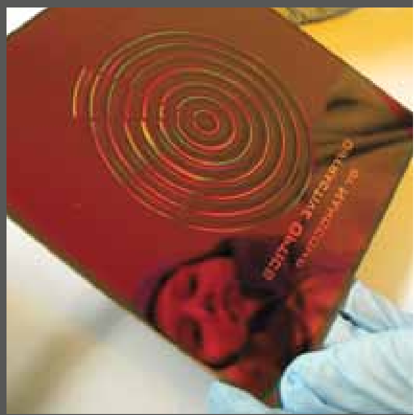
COMPANY

Nanocomp is a privately-held company established in 1997 to implement strong expertise in basic and applied optics research into advanced technology products. Focusing on design, manufacture and replication of optical components, Nanocomp carries out continuous research and development to provide versatile services for various branches of industry. Nanocomp's facilities are located in Lehmo, near the city of Joensuu in eastern Finland. Joensuu can be easily reached by several daily flight connections via Helsinki.



Value added partner

Nanocomp is the home of tailor-made diffractive optical solutions. The company considers itself to be a 'source of diffractive optics', a metaphor for creating new, revolutionary turnkey diffractive optical solutions for its customers. The company's mission is to 'create success stories' for its customers and partners. Long-term collaborative efforts starting from the early stage of feasibility studies, expanding step-by-step to the designing of structures, prototyping and sample production, as well as zero series production, which enables mass production, comprise the typical steps taken during successful co-operation. When it comes to collaboration and meeting its customer's product development and production needs, Nanocomp proves to be exceptionally flexible and innovative.



Milestones 1997–2010

1997	Founded in co-operation with the University of Joensuu, Finland Electron Beam Writing capabilities achieved
1998	First office premises established, 30 m^2, Joensuu Science Park 1st full-time employee hired First global customer
2000	Electroforming, hot embossing capabilities attained New clean room 60 m^2 and office premises 65 m^2 Staff expanded to 4 employees
2002	Direct Laser Writing capabilities attained Office space totals 180 m^2 and production space 125 m^2 Staff totals 7 employees Second global customer
2003	Roll to roll hot embossing capabilities achieved
2005	Plane UV moulding, Laser Interferometry capabilities are achieved
2007	New 2400 m^2 office and production premises are acquired New 215 m^2 clean room Number of staff reaches 10 employees
2008	ISO 9001:2008 certificated RIBE, UV imprint capabilities 20th staff member employed Several global customers
2009	ISO 14001:2004 and OHSAS 18001:2007 certificated UV roll-to-roll embossing capabilities reached
2010	Liaison Office established in Japan

SOURCE OF DIFFRACTIVE OPTICS

NANOCOMP LTD *is a high-tech company with extensive experimental as well as theoretical knowledge on diffractive optics. Focusing on optimization, fabrication and replication of optical components, we carry out continuous research and development to provide versatile services for various branches of industry that use microstructured components in their products.*

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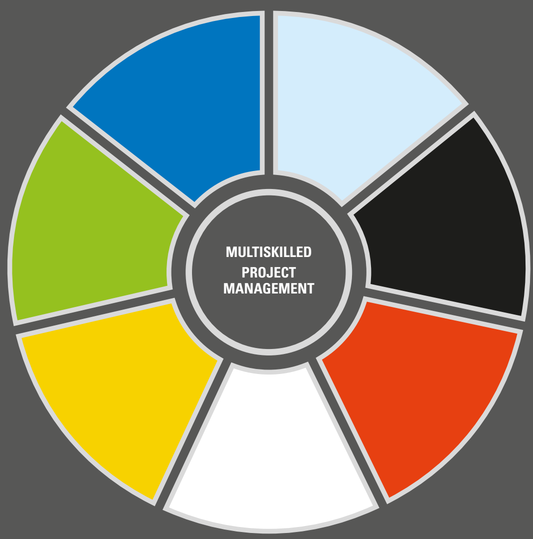
VALUE ADDED SERVICE CONCEPT

Nanocomp's knowledge in materials and diffractive optics makes it possible to develop new revolutionary applications to meet customer needs.



Defining the starting point

Approach possibilities

- Utilization of Nanocomp technologies
- Evaluation of new customer ideas
- Project planning

Feasibility study

- Study the possibilities of how to utilize diffractive structures in customer applications
- Evaluation of different solutions
- Improvement of customer's technologies with Nanocomp consultation and R&D support
- Next step proposal

Research and development

- Research and development of new customer products
- Optical concept design
- Idea concretization
- Material and manufacturing technology trials

Product design

- Optical design for new products and concepts
- Production conditions and boundaries
- Design iteration and optimization

Materials

- Use of existing materials
- New material testing and sourcing

Prototyping

- Manufacturing product demonstration and prototype

Patterning and Tooling

- Replication tools
- Replication methods
- Manufacturing of single high quality product
- Small series product demonstration

High Precision Replication

- Research of mass production possibilities
- Production ramp-up
- Large-scale mass production

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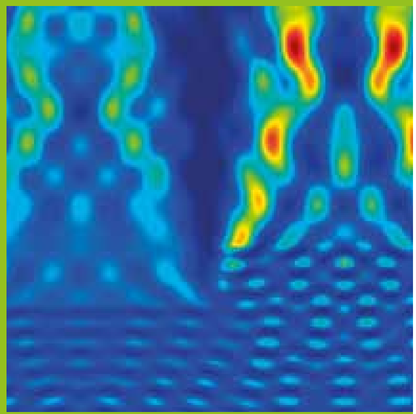
DESIGNING DIFFRACTIVE OPTICS AND NANO PHOTONICS

Nanocomp's expertise is increasingly capitalized upon in optical engineering of diffractive structures. Design, analysis and simulation of complex optical systems with the best features of rigorous and scalar diffractive theories are applied in the algorithms developed by the company.



SEND YOUR OWN DESIGN OR LET NANOCOMP CREATE THE DESIGN FOR YOU!

Resources

Nanocomp has wide resources available for diffractive optics design. Our staff includes several diffractive optics experts with over a decade of experience in the field and boasts six doctoral degrees in optics. Nanocomp's design tools include widely-used Matlab and Zemax, which both enable modern design methods. Lengthy experience has generated a library of ready-to-use codes and a wide range of case studies.

$$\nabla \cdot \mathbf{D} = \rho_f$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{H} = \mathbf{J}_f + \frac{\partial \mathbf{D}}{\partial t}$$

Design methods

Rigorous analysis of micro-optical components needs the exact solutions of Maxwell's equations and electromagnetic boundary conditions. The Fourier modal method – FMM - is a versatile approach to model two-dimensional gratings but it can also be extended to three-dimensionally modulated structures or structures with non-binary profiles.

Approximate methods are simple and fast approaches to analyze grating diffraction problems.

The iterative Fourier transform algorithm is one of the most popular methods for designing thin diffractive optical elements in the paraxial domain.

Structure optimization of various types of parameters is a classical problem in micro-optics. A typical task in the design of a micro structure is to find a suitable profile shape. Parametric optimization enables us to design structures for which the fabrication tolerances and limitations can be easily considered.

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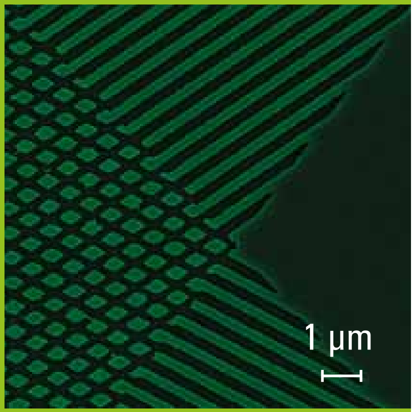
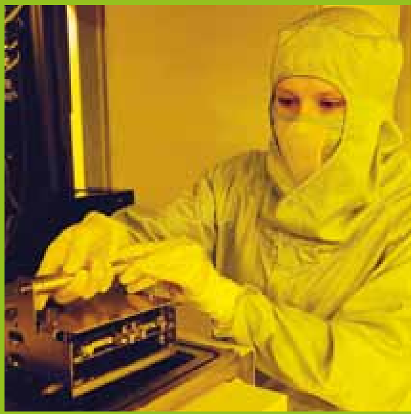
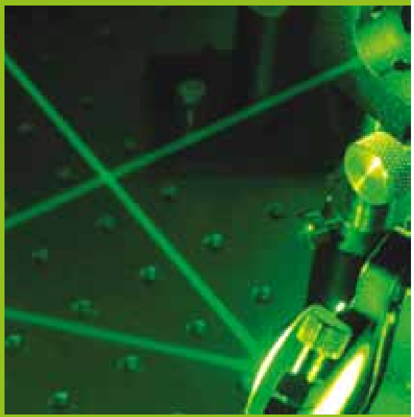
PATTERNING & TOOLING

Nanocomp offers several available technologies for the mastering of nano- and microstructures. Typically, the choice of the technology depends on technical specifications and production quantity. Modern manufacturing technologies with electron beam lithography, direct laser beam patterning as well as holographic recording enable the production of various nano- and micro-optical elements for sophisticated needs. These elements can be applied as tools for different replication technologies.







PATTERNING

Electron beam lithography

The strengths of electron beam lithography include very high resolution, flexible patterning and a high reproducibility. Vistec EBPG 5000+ES HR is a modern e-beam patterning tool capable of nanometer scale patterning accuracy. The drawbacks are the relatively slow writing speed and small pattern areas.

Direct laser lithography

Nanocomp has a high resolution pattern generator for direct writing with 442 nm HeCd-laser source. The system with related lithographic processes can be implemented for the manufacturing of applications that require micro-optical surface relief structures with micrometric scale.

Holographic interferometry

Holographic lithography patterning can be used for large area and uniform periodical gratings, for instance, for small display devices and outcouplers. Our setup fulfils the high quality requirements for uniform linewidth, low period variation and low scattering over the patterned area.

TOOLING

Nickel and glass tools for the mass production of microstructures

Applying electroforming to produce a nickel copy from the original nano- or microstructured master element is the most widely used approach to manufacture a replication tool. The process allows high-quality duplication of the master element, and therefore permits low cost production with accurate repeatability and excellent process control. Another approach is to use a manufactured glass mould directly for plastic replication. Glass moulds are advantageous in that they permit more complex structures to be used.

Manufactured tools can be used as a master element, for instance, in nano-imprint lithography technology, hot embossing, roll-to-roll embossing, UV-moulding or as a part of moulds for plastic injection moulding.

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HIGH PRECISION REPLICATION

We offer the expertise and high production capacity for product or product parts replication for advanced optical applications developed in close collaboration with our customers. Our production lines include replication technologies such as UV- moulding, roll-to-roll embossing, UV roll-to-roll embossing, hot embossing of small series of plastic replicas and large volume replication by plastic injection moulding.

In principle, the replication process transfers a surface profile from the master element into the necessary replication material. The basic replication technologies allow for the low-cost mass-production of diffractive optical elements.

Annual Volume/ Technology	*Hot Embossing*	*Roll-to-roll embossing*	*UV-moulding*	*UV roll-to-roll embossing*
10–100	x	x	x	
100–1 000		x	x	
1 000–10 000		x	x	x
10 000–500 000			x	x
500 000 +				x

Roll-to-roll embossing

Traditional roll-to-roll embossing involves essentially stamping a pattern onto a certain polymer material with the use of heat for polymer curing. Our roll-to-roll embossing machine is designed for embossing optical diffraction patterns or holographic images onto specialized plastic and films.

UV- moulding

UV-moulding, in which replication takes place into ultra-violet curable polymers, is a frequently applied method for the replication of planar micro- and nanostructures. This method has proven to be suitable for producing highly-accurate optical microsystems and diffractive optics. UV-embossing can be efficiently carried out at the wafer scale for mass production. Most of the process steps are fully automated. In addition, its highly accurate alignment capability enables the production of double-sided replicated components on an industrial scale.

UV roll-to-roll embossing

UV roll-to-roll embossing is the tried-and-true mass production manufacturing method for diffractive optics. Tens of thousands of can be manufactured within a matter of days. First the desired structure is produced using lithography on the master substrate. This master substrate is replicated into several nickel tools which can be used for UV roll-to-roll embossing to create the final product in mass quantities. The advantages of UV roll-to-roll embossing are high volumes and the absence of heat-related problems.

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EXAMPLE APPLICATIONS

Machine vision components

based on PATTERN GENERATORS

Machine vision components for use in bottle recycling machines are uniquely designed and fabricated by Nanocomp. A red laser produces a 29 x 7 dot matrix as output signal, which together with a scanning camera and electronics produces a sharp high-resolution depth map.

Components for optimized color analysis

based on WIDE BAND SPECTROSCOPIC GRATINGS

Blazed gratings allow high diffraction efficiency at a predetermined wavelength. Typical applications are in spectral cameras, microspectrometers and the analysis of RGB color coordinates. Typical grating period is 4-20 um and grating height 2-10 um.

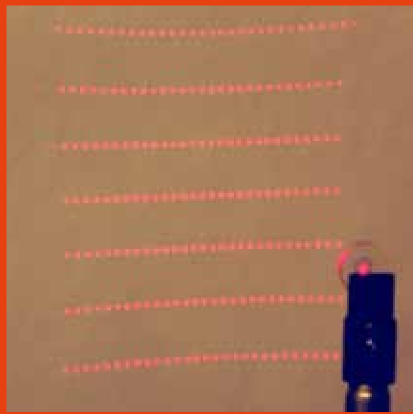
Thin foil light-guides for led applications

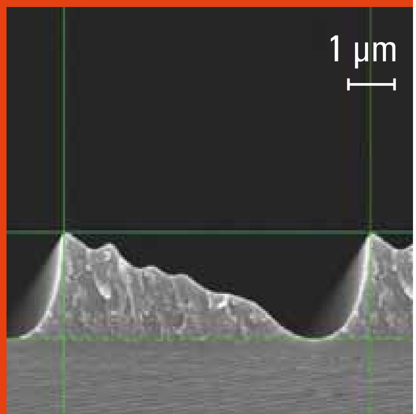
produced by REEL-TO-REEL TECHNOLOGY

Nanocomp's UV reel-to-reel embossing technology enables large volume production of high performance micro-elements for general illumination applications and for micro-displays, keymats and on-cover optics. Nanocomp thin light guides are produced as thin plastic foil with microstructure replicated on one side of the foil. Typical foil thickness is 0.250 mm. Plastic foil can be integrated in several ways according to customer requirements. It can be glued to injection-molded base or integrated directly during injection molding.

Customized diffractive optical components

Nanocomp has over 10 years experience in designing diffractive optical solutions. Send us your optical requirements and let's find a solution together.





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EXAMPLE TECHNOLOGIES

Replicated high efficiency slanted gratings

based on LIGHT COUPLING COMPONENTS

Light incoupling and outcoupling gratings are typically used in a wide variety of light guides. Slanted gratings offer important advantages over binary gratings. Although more difficult to manufacture, slanted gratings increase coupling efficiency into light guides by up to 80%. Typical grating periods are 400-600 nm, grating heights 100-600 nm and slanted angles 35-55 degrees. > PICTURE 1

Multilevel structures

for PATTERN GENERATORS

High quality pattern generators, enabling the use of complex design algorithms, are constructed of multilevel structures. Pixelated structures can be fabricated with anywhere from 8 to 128 levels, and in some products with a continuous profile. Typical pixel size starts from 0.5 um. > PICTURE 2

Double groove gratings

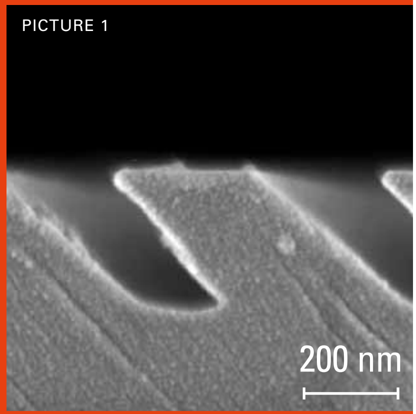
for SPECTROSCOPIC APPLICATIONS

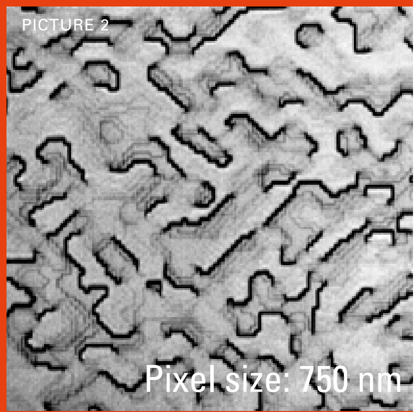
Double groove gratings, which find use in spectroscopic applications, offer high efficiency over a wide spectral range. Typical grating period and height is about 1 µm with high aspect ratio grating lines within one period. > PICTURE 3

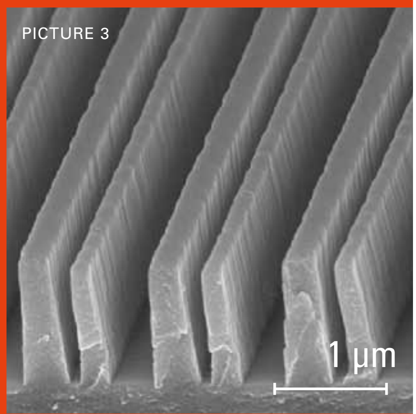
Replicated high aspect ratio gratings

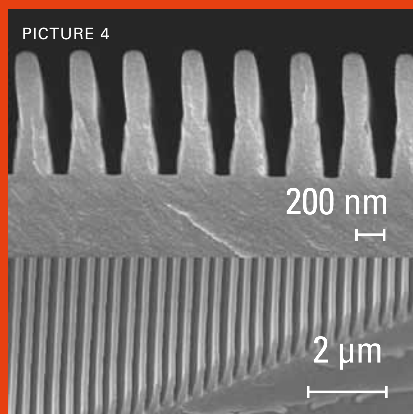
for POLARIZATION SHAPING COMPONENTS

Novel UV-replicable plastic materials enable the replication of high aspect ratio gratings. An interesting application is a form birefringence quarter-wave plate for use in light polarization shaping. A typical grating has a sub-micron period, 0.5 fill factor and very high aspect ratio in range of 5-10. > PICTURE 4









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