this case, the intention is to enable in particular a high write speed and thus a throughput suitable for industrial fabrication.

Disclosure of the invention

Summary

In an aspect, the present disclosure refers to a method for lithographically producing a target structure on a non-planar initial structure by exposing a photoresist by means of at least one lithography beam, comprising the following steps:

a) detecting a topography of a surface of a non-planar initial structure;

b) using at least one test parameter for the lithography beam and determining an interaction of the lithography beam with the initial structure and the resultant change in the lithography beam and/or the target structure to be produced;

c) determining at least one correction parameter for the lithography beam in such a way that the change in the lithography beam and/or the target structure to be produced that is caused by the interaction of the lithography beam with the initial structure is reduced; and

d)producing the desired target structure on the initial structure by exposing the photoresist by means of the at least one lithography beam using the at least one correction parameter for the lithography beam.

In an aspect, the present disclosure refers to a device for lithographically producing a target structure on a non-planar initial structure by exposing a photoresist by means of at least one lithography beam according to a method as claimed in any of the preceding claims, at least comprising

- a lithography unit for generating a lithography beam and for positioning the lithography beam within a photoresist;

- a beam shaping unit configured for influencing an amplitude and/or phase distribution of the lithography beam; and

- a data processing unit configured for driving the lithography unit and the beam shaping unit, wherein the data processing unit is furthermore configured to store structure data of the target structure to be produced and data for correcting the change in the lithography beam that is caused by an interaction of the lithography beam with the non-planar initial structure.

This object is achieved by means of a method and a device for lithographically producing a target structure on a non-planar initial structure having the features of the independent patent claims. Advantageous developments, which are realizable individually or in any desired combination, are presented in the dependent claims.

Hereinafter the terms “have”, “encompass”, “comprise” or “include” or any grammatical departures therefrom are used non-exclusively. Accordingly, these terms can refer either to situations in which, besides the features introduced by these terms, no further features are present, or to situations in which one or more further features are present. By way of example, the expression “A has B”, “A encompasses B”, “A comprises B” or “A includes B” can refer either to the situation in which, apart from B, no further element is present in A (i.e. to a situation in which A exclusively consists of B), or to the situation in which, in addition to B, one or more further elements are present in A, for example element C, elements C and D or even further elements.

Furthermore, it is pointed out that the terms “at least one” and “one or more” and grammatical modifications of these terms, if they are used in association with one or more elements or features and are intended to express the fact that the element or feature can be provided singularly or multiply, generally are used only once, for example when the feature or element is introduced for the first time. When the feature or element is subsequently mentioned again, the corresponding term “at least one” or “one or more” is generally no longer used, without restricting the possibility that the feature or element can be provided singularly or multiply.

Furthermore, hereinafter the terms “preferably”, “with preference”, “in particular”, “for example” or similar terms are used in conjunction with optional features, without alternative embodiments being restricted thereby. In this regard, features introduced by these terms are optional features, and the scope of protection of the claims, and in particular of the independent claims, is not intended to be restricted by these features. In this regard, the invention, as will be recognized by the person skilled in the art, can also be carried out using other configurations. In a similar way, features introduced by “in one embodiment of the invention” or by “in one exemplary embodiment of the invention” are understood as optional features, without alternative configurations or the scope of

protection of the independent claims being intended to be restricted thereby. Furthermore, all possibilities of combining the features introduced by these introductory expressions with other features, be they optional or non-optional features, are intended to remain unaffected by these introductory expressions.

In a first example, the present disclosure relates to a method for lithographically producing a target structure on a non-planar initial structure.

In this case, the “lithographically producing” refers to producing the target structure by exposing a photoresist in at least one exposure step by means of a lithography beam or by means of a plurality of lithography beams, which can also be referred to as “lithography beam bundle”, and at least one subsequent development step. In association with the present invention, the “lithography beam” denotes a light beam that is used in the method, also referred to as “lithography” to interact with the photoresist during the exposure step in such a way that the photoresist is changed such that after the development step has been carried out, the desired target structure is obtained in the developed photoresist. In this case, the term “interaction” denotes mutual action of the lithography beam on the photoresist and vice versa, whereby the respective properties thereof can be changed. By way of example, the lithography beam can change the solubility of the photoresist within a volume element of the photoresist, wherein the photoresist on the other hand can have an influence on a parameter of the lithography beam.

The “photoresist” comprises a light-sensitive material, preferably a polymer, in particular an acrylate, a methyl methacrylate or an Ormocer. Depending on absorption properties of the selected light-sensitive material, the exposure of the photoresist can be carried out with a wavelength in at least one spectral range of the electromagnetic spectrum, preferably the visible, infrared or ultraviolet spectral range. In this case, the exposure of the photoresist with the lithography beam can bring about a change in a property of the light-sensitive material, in particular a change in the optical properties of the photoresist, preferably the refractive index of the photoresist or a solubility of exposed partial regions of the light-sensitive material, wherein, depending on selected material for the photoresist, the solubility can decrease (so-called “negative photoresist”) or increase (so-called “positive photoresist”). Depending on the type of change, in the development step following the at least one exposure step, the exposed partial regions of the light-sensitive material in the positive photoresist or the unexposed partial regions of the light-sensitive material in the negative photoresist can thus be dissolved away, whereby the target structure can be obtained.

In a further example the present disclosure relates to a device – also referred to as "lithography system" – for lithographically producing a target structure on a non-planar initial structure by exposing a photoresist by means of at least one lithography beam according to a method according to the disclosure. In this case, the device at least comprises:

- a lithography unit for generating a lithography beam and for positioning the lithography beam within a photoresist;
- a beam shaping unit configured for influencing an amplitude and/or phase distribution of the lithography beam; and
- a data processing unit configured for driving the lithography unit and the beam shaping unit, wherein the data processing unit is furthermore configured to store structure data of the structure to be produced and correction data for correcting the change in the lithography beam that is caused by an interaction of the lithography beam with the non-planar initial structure.

The lithography unit thus serves for generating the lithography beam and for positioning the lithography beam within the photoresist, which can simultaneously also be used as an immersion liquid. In this case, the positioning of the lithography beam can be carried out by the movement of the lithography beam, e.g. by means of beam scanners. Alternatively or additionally, a displacement of the initial structure can be performed by means of a displacement unit, in particular a displacement table on which the initial structure is arranged. The lithography unit can comprise an optical light source having a controllable output power, e.g. a light source having a constant output power and a downstream optical modulator. In this case, it may be advantageous if the movement of the lithography beam and the adaptation of the optical power guided in the beam can be synchronized. This makes it possible, for example, as the focal point approaches an edge of the non-planar initial structure that changes the lithography beam, to increase the optical power in the lithography beam upon approaching the edge.

The term "beam shaping unit" denotes an optical system configured to set the amplitude and phase distribution of the lithography beam. The beam shaping unit, if correspondingly short response times are present, can preferably be driven synchronously with the beam movement. Alternatively, it can be operated such that the same settings of the beam shaping unit are used for partial regions of the target structure. The beam shaping unit can preferably comprise at least one controllable optical element, in particular selected from the group comprising spatial light modulators (SLM), micromirror arrays, liquid crystal arrays, deformable mirrors, or controllable diaphragms. Furthermore, it can comprise other optical systems having controllable or non-controllable optical components, such as e.g.