component is fixedly connected to a first beam-shaping element such that a first optical component that is supplemented by the first beam-shaping element is present, wherein the second optical component is fixedly connected to a second beam-shaping element that is separate from the first beam shaping element such that a second optical component which is supplemented by the second beam-shaping element is present~~, wherein the first beam-shaping element and the second beam-shaping element are obtainable in situ using a three-dimensional direct writing lithography method~~. The first beam-shaping element is adapted to change the first beam profile and the second beam-shaping element is adapted to change the second beam profile such that an optical coupling between the optical components is effected, wherein the first beam-shaping element and the second beam-shaping element are ~~obtainable~~ obtained in situ at the target position by way of a three-dimensional direct-writing lithography method in a manner that a positioning accuracy with which the beam-shaping components can be realized on the optical components are better than 500 nm, and wherein the first optical component, which is supplemented by the first beam-shaping element and the second optical component, which is supplemented by the second beam-shaping element, are positioned and fixed on a common base plate.

The present optical system thus differs in particular from optical arrangements known from the prior art in that the beam-shaping elements are produced in situ at the target position, preferably directly at a structural element facet or at corresponding holding structures of one of the optical components, by way of a three-dimensional direct-writing lithography method and in that the beam-shaping elements can be deliberately used to improve the coupling efficiency between two optical components and to increase the associated positioning tolerances. In particular, the beam-shaping elements are here produced in situ at the target position in accordance with step c) of the method described here.

In a preferred configuration, each of the two optical components can have a dedicated beam-shaping element, with the result that the optical system comprises two optical components, which are supplemented each by a beam-shaping element. However, optical systems in which the two optical components share a common beam-shaping element obtainable in situ at the target position using a three-dimensional direct-writing lithography method are also conceivable.

In a particularly preferred configuration, the beam-shaping elements are here designated each in terms of shape and positioning such that the optical coupling between the optical components has at least one defined coupling efficiency at a selected positioning accuracy.

In particular, each of the optical components is selected from the group comprising single-mode fibers or multi-mode fibers made of organic or inorganic materials, semiconductor-

Claims

1. A method for producing an optical system, having at least two separate optical components, wherein the at least two separate optical components are mounted on a common base plate, and at least one optical connection between the at least two separate optical components, comprising the following steps:
   a) providing a first optical component and a second, separate optical component, wherein the first optical component has a first beam profile and the second optical component has a second beam profile;
   b) designing the optical system by specifying an arrangement of the first optical component and the second optical component and by specifying a form and target position of a first beam-shaping element and a separate second beam-shaping element, wherein the first beam-shaping element is fixedly connected to the first optical component and the second beam-shaping element is fixedly connected to the second optical component, wherein the first beam-shaping element is designated to change the first beam profile and the second beam-shaping element is designated to change the second beam profile such that, after positioning of the first optical component and of the second optical component, an optical coupling between the first optical component and the second optical component is formed;
   c) producing the first beam-shaping element and the second beam-shaping element using a three-dimensional direct-writing lithography method in situ at the target position, as a result of which the first optical component which is supplemented by the first beam-shaping element and the second optical component which is supplemented by the second beam-shaping element is obtained; and
   d) positioning and fixing of at least one of the first optical component, which is supplemented by the first beam-shaping element, and the second optical component, which is supplemented by the second beam-shaping element, on the common base plate, as a result of which the optical system is obtained.

2. The method as claimed in the preceding claim, wherein the production of the first beam-shaping element and of the second beam-shaping element using the three-dimensional direct-writing lithography method in situ at the target positions at the first optical component and at the second optical component includes determining alignment marks applied on the two separate optical components for positioning the first beam-shaping element relative to the first optical component and positioning the second beam-shaping element relative to the second optical component.

3. The method as claimed in one of the preceding claims, wherein for the optical connection a beam path is selected which has at least one portion selected from a beam-expanding portion, a collimated portion, or a beam-narrowing portion, wherein the beam-expanding portion is designated to increase a local beam divergence, wherein the collimating portion is designated to keep a beam diameter constant, and wherein the beam-narrowing portion is designated to reduce a local beam divergence.

4. The method as claimed in the preceding claim, wherein the beam path comprises a beam-expanding part, a waveguide, and a collimating part being designed for reducing a divergence of an exiting beam.

5. The method as claimed in one of the preceding claims, wherein a beam of the optical connection outside the first beam-shaping element and the second beam-shaping element has a diameter of 5 µm to 100 µm.

6. The method as claimed in claim 1, wherein interspaces between the first beam-shaping element and the second beam-shaping element are filled at least partially with an optically transparent material, wherein the optically transparent material is designated to reduce at least one of reflection losses between the first beam-shaping element and the second beam-shaping element or a chromatic aberration of a light beam passing through the first beam-shaping element and the second beam-shaping element.

7. The method as claimed in one of the preceding claims, wherein a solid material having a refractive index which changes due to the exposure to light is used to produce the first beam-shaping element and the second beam-shaping element.

8. The method as claimed in one of the preceding claims, wherein at least one of the first and second optical components is designated in the form of an optical chip, wherein the at least one of the first and second beam-shaping elements applied on the optical chip is embodied such that a deflection of light propagating in a plane of the optical chip into a direction that is oriented at an angle with respect to a surface of the optical chip is effected or light from a direction that is oriented at an angle with respect to a surface of the optical chip is deflected in a propagation direction that is located in the surface of the optical chip, wherein the angle is at least 50° relative to the surface of the optical chip.

9. The method as claimed in the preceding claim, wherein light traverses a further optical chip, or light traverses an optically transparent window located in the optical chip or in the further optical chip.

10. The method as claimed in one of the two preceding claims, wherein the light propagating from the first optical component is coupled into a further second optical component applied on a second optical chip, and wherein the first beam-shaping element and the second beam-shaping element applied on the first optical chip and the second optical chip are designated such that they deflect light from a direction which is oriented at the angle with respect to the surface of the second optical chip into a propagation direction which is located in the plane of the second optical chip.

11. An optical system, comprising two separate optical components, wherein each of the optical components is mounted on a common base plate, wherein a first optical component of the optical components has a first beam profile and a second optical component of the optical components has a second beam profile, wherein the first optical component is fixedly connected to a first beam-shaping element such that a first optical component which is supplemented by the first beam-shaping element is present, wherein the second optical component is fixedly connected to a second beam-shaping element that is separate from the first beam shaping element such that a second optical component which is supplemented by the second beam-shaping element is present, ~~wherein the first beam-shaping element and the second beam-shaping element are obtainable in situ by way of a three-dimensional direct-writing lithography method,~~ wherein the first beam-shaping element is adapted to change the first beam profile and the second beam-shaping element is adapted to change the second beam profile such that an optical coupling between the optical components is effected, wherein the first beam-shaping element and the second beam-shaping element are ~~obtainable~~ obtained in situ at the target position by way of a three-dimensional direct-writing lithography method in a manner that a positioning accuracy with which the beam-shaping components can be realized on the optical components are better than 500 nm, and wherein the first optical component, which is supplemented by the first beam-shaping element, and the second optical component, which is supplemented by the second beam-shaping element, are positioned and fixed on a common base plate.

12 The optical system as claimed in the preceding claim, wherein the at least one of the first beam-shaping element and the second beam-shaping element has at least one part selected from a beam-expanding part, a collimating part, or a beam-narrowing part, wherein the beam-expanding part is designated to increase a local beam divergence, wherein the collimating part is designated to keep a beam diameter constant, and wherein the beam-narrowing part is designated to reduce a local beam divergence.

13. The optical system as claimed in the preceding claim, wherein at least one of the first beam-shaping element and the second beam-shaping element comprises a beam-expanding part, a waveguide, and a collimating part reducing a divergence of an exiting beam.

14. The optical system as claimed in one of the two preceding claims, wherein the beam-expanding part has a structure which is selected from a reflective structure, a refractive structure, a light-guiding structure, or a diffractive structure.

15. The optical system as claimed in one of the four preceding claims, wherein at least one further optical component is located between the first beam-shaping element and the second beam-shaping element.

16. The optical system as claimed in one of the five preceding claims, wherein at least one of the first optical component and the second optical component has a waveguide, which does not meet a facet of the optical components perpendicularly, and wherein at least one of the first beam-shaping element and the second beam-shaping element merges beam propagation directions into one another.