DEVICE AND METHOD FOR EXPOSING A LIGHT-SENSITIVE LAYER TO LIGHT

The present invention relates to a method for exposing a light-sensitive layer to light and to a corresponding device.

Digital micro-mirror devices (DMDs) have been known in the art for a long time. These are optical elements which consist of a plurality of small mirrors which can be individually moved/aligned. Each mirror can be selectively electrically activated and oriented. This means that an optical system with a DMD can be used to selectively deflect a broad light beam in a spatially resolved manner. In most cases only two fully deflected positions per mirror are under consideration. Either a mirror allows the incident part of the light beam to pass through the optical system or it reflects the incident part of the light beam in such a way that the light is not passed further through the system. Each mirror of such a DMD can then be interpreted as a digital light switch.

In the art DMDs of this kind are used above all in projectors. They are also increasingly used in industrial environments, for example in 3D printing, 3D surveys and maskless lithography.

In the art all the known maskless exposure devices have a single light source, which irradiates the DMD and thus the surface to be exposed.

Embodiments of the present invention eliminate the disadvantages of the state of the art and in particular achieve an improved exposure result.

According to a first aspect of the present invention, there is provided a method for exposing a light-sensitive layer to light using an optical system, the method including: directing at least one light beam generated by at least one light source, respectively, to at least one micro-mirror device having a plurality of micro-mirrors to respectively illuminate one or more pixels to generate an image of the micro-mirror device, effecting, via two cylinder lenses, a shearing of the generated image to form horizontal and/or vertical exposure pattern grid lines of a pattern grid to which the light-sensitive layer is exposed, each of the cylinder lenses having a cylinder axis, wherein greater than 50% of an energy of each of the pixels is found in a field of the light-sensitive layer having an image that directly corresponds with the pixel, and wherein a remaining amount of the energy of each of the pixels is distributed across adjacent fields to the field having the image that directly corresponds with the pixel.

According to a second aspect of the present invention, there is provided a device for exposing a light-sensitive layer the device including: at least one light source for respectively generating at least one light beam, at least one micro-mirror device toward which the light beam is directed by the light source, the micro-mirror device having one or more of micro-mirrors having one or more micro-mirrors configured to respectively illuminate one or more pixels to generate an image of the micro-mirror device, two cylinder lenses, each cylinder lens having a cylinder axis, the cylinder lenses being configured to effect a shearing of the generated image to form horizontal and/or vertical exposure pattern grid lines of a pattern grid to which the light-sensitive layer is exposed, wherein greater than 50% of an energy of each of the pixels is found in a field of the light-sensitive layer having an image that directly corresponds with the pixel, and wherein a remaining amount of the energy of each of the pixels is distributed across adjacent fields to the field having the image that directly corresponds with the pixel.

The scope of the invention also covers all combinations of at least two features indicated in the description, the claims and/or the drawings. In case of value ranges, all values within the said limits are deemed disclosed as limit values and can be claimed in random combination.

The invention shows, in particular, how an improved, faster higher-resolution exposure operation can be carried out.

The core idea of the invention consists in performing a distortion of the DMD image with the aid of optical elements in such a way that an increased resolution can be achieved from the pattern of the intensity profiles.

The intensity profile is preferably chosen such that 50% of the energy of a pixel are to be found in the directly corresponding image surface and a further 50% are distributed across the adjacent fields. In a more preferred embodiment according to the invention the intensity profile of a pixel is chosen such that more than 50% of the energy of a pixel are to be found in the directly corresponding image surface and the remaining less than 50% are distributed across the adjacent fields. In another less preferred embodiment according to the invention the intensity profile of a pixel is chosen such that less than 50% of the energy of a pixel are to be found in the directly corresponding image surface and the remaining more than 50% are distributed across the adjacent fields.

In particular, the invention describes a maskless exposure device / a maskless exposure method. The exposure device is described by way of a number of embodiments which can be combined with each other.

Claims

1. A method for exposing a light-sensitive layer to light using an optical system, the method comprising:

directing at least one light beam generated by at least one light source, respectively, to at least one micro-mirror device having a plurality of micro-mirrors to respectively illuminate one or more pixels to generate an image of the micro-mirror device,

effecting, via two cylinder lenses, a shearing of the generated image to form horizontal and/or vertical exposure pattern grid lines of a pattern grid to which the light-sensitive layer is exposed, each of the cylinder lenses having a cylinder axis,

wherein greater than 50% of an energy of each of the pixels is found in a field of the light-sensitive layer having an image that directly corresponds with the pixel, and

wherein a remaining amount of the energy of each of the pixels is distributed across adjacent fields to the field having the image that directly corresponds with the pixel.

2. The method according to claim 1, wherein the horizontal and/or vertical exposure pattern grid lines are arranged obliquely.

3. A device for exposing a light-sensitive layer the device comprising:

at least one light source for respectively generating at least one light beam,

at least one micro-mirror device toward which the light beam is directed by the light source, the micro-mirror device having one or more of micro-mirrors having one or more micro-mirrors configured to respectively illuminate one or more pixels to generate an image of the micro-mirror device,

two cylinder lenses, each cylinder lens having a cylinder axis, the cylinder lenses being configured to effect a shearing of the generated

image to form horizontal and/or vertical exposure pattern grid lines of a pattern grid to which the light-sensitive layer is exposed,

wherein greater than 50% of an energy of each of the pixels is found in a field of the light-sensitive layer having an image that directly corresponds with the pixel, and

wherein a remaining amount of the energy of each of the pixels is distributed across adjacent fields to the field having the image that directly corresponds with the pixel.

4. The method of claim 1, wherein the two cylinder lenses are combined to form a compound lens.

5. The device of claim 3, wherein the two cylinder lenses are combined to form a compound lens.