Often when integrated camera modules or optical modules for camera modules are diced, material loosens and drops into the space between the wafer dices, for example onto the sensor module or onto a lens. This causes a lot of reject cameras or optical modules and as a consequence increases the cost.

SUMMARY OF THE INVENTION

Embodiments~~It is an object~~ of the invention seek to provide an improved method and an improved optical device that overcomes drawbacks of prior art methods and optical devices. An optical device in this may be a camera or an optical module for a camera that is suitable of directing incoming radiation in an appropriately focused manner onto a sensor device of the camera.

In accordance with a first aspect of the invention, there is provided a method of manufacturing, on a wafer scale, a plurality of optical devices being camera modules with a sensor module or being optical modules for camera modules with a sensor module, wherein a camera module with a sensor module may be identified with a camera, and wherein each of the cameras has sub-cameras for capturing sub-images of red, green, or blue color, the optical devices each defining an optical path, the method comprising the steps of: providing a first wafer scale substrate comprising a pattern of lenses and comprising a wavelength selective filter that is patterned to comprise a plurality of filter sections which are color filters of the sub-cameras for capturing sub-images of red, green, or blue color; providing a wafer scale spacer with a plurality of holes arranged in a hole pattern that corresponds to the pattern of lenses; stacking the first substrate and the spacer on each other with the holes and the lenses being aligned, and with the filter sections being arranged and dimensioned so that the respective optical path traverses the respective filter section, the step of stacking yielding a wafer scale stack, and separating the wafer scale stack into the optical devices.

In accordance with a second aspect of the invention, there is provided a wafer scale optical substrate, comprising a substrate body of an optically transparent material with two essentially plane parallel surfaces, and further comprising a wavelength selective filter applied to a first one of the surfaces, the filter comprising a plurality of filter sections that are mutually spaced from each other and are arranged in an array and which are color filters of sub-cameras for capturing sub-images of red, green, or blue color.

In accordance with a third aspect of the invention, there is provided a camera having sub-cameras for capturing sub-images of red, green, or blue color, the camera comprising a sensor module and an optical system defining an optical axis, the camera comprising at least one spacer, and at least one transparent substrate of the optical system, the substrate carrying an optical element, wherein the sensor module, the spacer, and the substrate with the optical element are stacked vertically with respect to the optical axis, wherein at least one filter adheres to the substrate, wherein the substrate has a first area perpendicular to the optical axis, wherein the filter has a second area that is smaller than the first area and wherein an optical path defined by the optical system and the sensor module traverses the filter, wherein the filter comprises a plurality of filter sections which are color filters of the sub-cameras for capturing sub-images of red, green, or blue color.

In accordance with a fourth aspect of the invention, there is provided a method of manufacturing a color image, comprising the steps of capturing sub-images of red, green, and blue color, respectively, by means of a camera according to the third aspect, wherein said sub-images are captured by means of the sub-cameras of said camera; and combining the sub-images to the color image.

In accordance with an embodiment~~aspect~~ of the invention, the method comprises the steps of providing a wafer scale spacer with a plurality of holes arranged in a hole pattern at the positions of camera modules, providing a wafer scale substrate with a wavelength selective filter, such as an infrared (IR) filter that is patterned to

comprise a plurality of filter sections, the filter sections being arranged in a filter pattern that is such that radiation paths through the substrate and onto the camera modules go through the filter sections, and stacking the substrate and the spacer on each other with the holes and the filter sections being aligned.

In general, the filter will be traversed by the optical path. In this, the optical path is the sum of all ray paths that go through the optical components, generally through a system aperture, and onto the sensor module, thus the sum of all ray paths that contribute to the image to be generated.