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Barcode Marking of Waveguides Using Ultrafast Laser Processing

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Recommended Citation

n/a, "Barcode Marking of Waveguides Using Ultrafast Laser Processing", Technical Disclosure Commons, (December 01, 2021)

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Barcode Marking of Waveguides Using Ultrafast Laser Processing

ABSTRACT

This disclosure describes techniques to provide markings such as barcodes on waveguides that can enable serialization and improve traceability. Modifications are induced in the form of barcode patterns on the waveguide using ultrafast laser processing. The markings are provided at a location that lies outside a clear aperture area of the waveguide so as to not affect its optical properties and performance. The barcode markings can be provided by utilizing ultrafast laser processing to induce modifications either within the waveguide substrate(s) or to the coatings on the waveguide substrate. The modifications can be induced by a specially designed laser system with parameters optimized for marking or by an ultrafast laser system that is also utilized for marking the waveguide wafer prior to waveguide wafer dicing. Techniques of this disclosure can provide permanent waveguide traceability while maintaining waveguide strength and purity.

KEYWORDS

- Waveguide
- Ultrafast laser
- Augmented Reality (AR) headset
- Wafer marking
- Barcode
- Traceability
- Ablation
- Picosecond laser

BACKGROUND

Display components of devices such as Augmented Reality (AR) or Virtual Reality (VR) headsets commonly include a waveguide to transmit an optical image signal from a projector to the eye. The waveguide is a thin (e.g., <1mm thick) glass piece that can be patterned using semiconductor or other fabrication processes. Multiple sets of waveguides are first patterned onto a wafer (e.g. 100mm - 300mm diameter), which are then cut to yield multiple waveguides that are subsequently utilized in products such as AR and VR headsets.

Traceability of waveguides in products can be enhanced if the individual waveguides can be provided with identifier markings, e.g., serial number markings, etc. Marking of waveguides can pose challenges because of additional risks introduced by the marking process, e.g., reduced waveguide strength against breakage, introduction of debris that affects waveguide optical properties, etc.

DESCRIPTION

This disclosure describes techniques to provide markings such as barcodes on waveguides that can enable serialization and improve traceability of waveguides. Per techniques of this disclosure, modifications are induced on the waveguide using laser processing, e.g., ultrafast laser processing, in the form of barcode patterns. The barcode patterns are designed such that they do not affect the waveguide performance or properties. For example, the barcode is designed to be minimal in size, and is placed outside the waveguide's clear aperture.

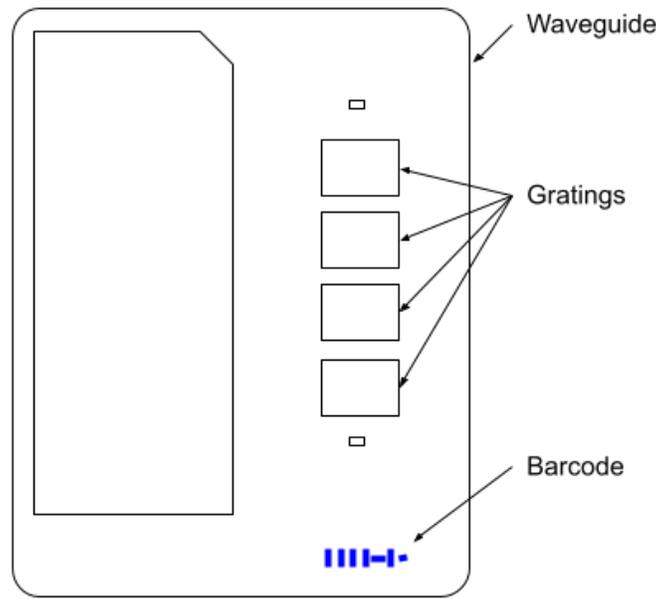


Fig. 1: Barcode markings enable improved waveguide traceability

Fig. 1 depicts an example waveguide with barcode markings, per techniques of this disclosure. In this illustrative example, the waveguide includes multiple variously sized gratings. As depicted in Fig. 1, barcode markings are provided at a location in the waveguide that lies outside a clear aperture area of the waveguide so as to not affect its optical properties and performance. The barcode markings are designed to be minimal in size. For example, the dashes that comprise the barcode can be only 0.1 mm in length and separated by a distance greater than approximately 0.3 mm.

The barcode markings can be provided by utilizing ultrafast laser processing to induce modifications either within the waveguide substrate(s) or to the coatings on the waveguide substrate. In some implementations, the modifications can be induced by a specially designed laser system with parameters optimized for marking. In some implementations, the modifications can be induced by an ultrafast laser system that is also utilized for marking the waveguide wafer prior to waveguide wafer dicing.

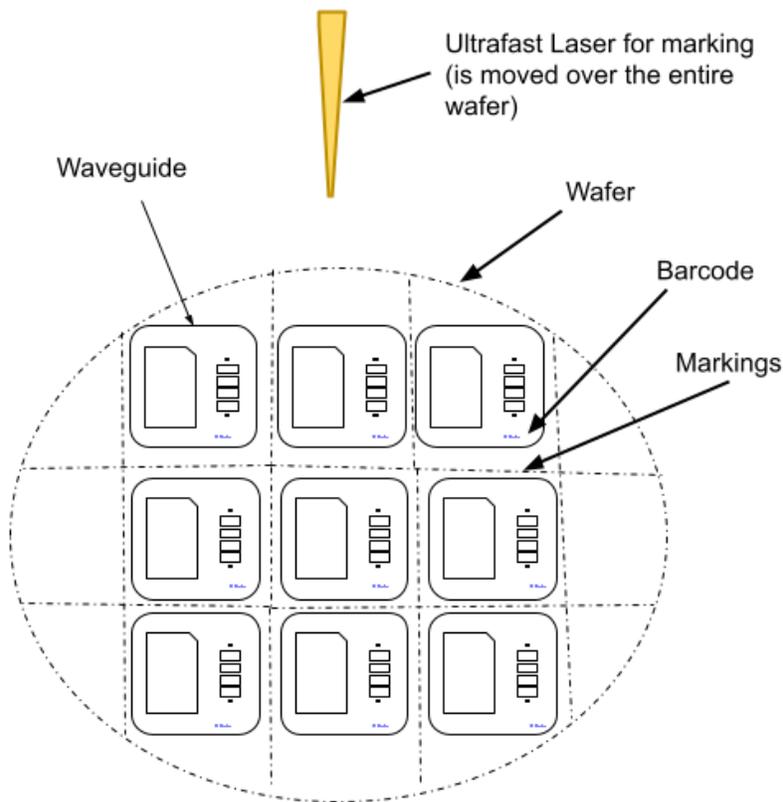


Fig. 2: Barcodes marked using Ultrafast Laser Processing

Fig. 2 depicts an example marking process for waveguides, per techniques of this disclosure. An ultrafast laser is utilized to mark a patterned wafer and to delineate the individual waveguide profiles (dashed-dotted lines), as depicted. During the marking process for waveguide delineation, the barcode pattern determined by software, can also be marked at a designated location on each waveguide.

The waveguide marking can be provided using different methods.

Ablate waveguide coating(s)

In this method, only the waveguide coating layer is modified (without affecting the waveguide substrate). This can serve to preserve the waveguide substrate strength against breakage; however, ablation debris can pose risks of cleanliness deterioration.

Minimally modify the waveguide substrate

In this method, the waveguide substrate is minimally modified. This method is relatively debris free while posing a risk of deteriorating waveguide strength against breakage.

Techniques of this disclosure can be utilized to provide permanent waveguide traceability while still maintaining waveguide strength and purity (e.g., cleanliness).

CONCLUSION

This disclosure describes techniques to provide markings such as barcodes on waveguides that can enable serialization and improve traceability. Modifications are induced in the form of barcode patterns on the waveguide using ultrafast laser processing. The markings are provided at a location that lies outside a clear aperture area of the waveguide so as to not affect its optical properties and performance. The barcode markings can be provided by utilizing ultrafast laser processing to induce modifications either within the waveguide substrate(s) or to the coatings on the waveguide substrate. The modifications can be induced by a specially designed laser system with parameters optimized for marking or by an ultrafast laser system that is also utilized for marking the waveguide wafer prior to waveguide wafer dicing. Techniques of this disclosure can provide permanent waveguide traceability while maintaining waveguide strength and purity.

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