AUTOMATIC RECIPE MANAGEMENT FOR LASER PROCESSING A WORK PIECE

RELATED APPLICATION

This application claims benefit of U.S. Provisional Patent Application No. 61/061,439, filed Jun. 13, 2008.

TECHNICAL FIELD

The present invention relates to laser processing a work piece and, in particular, to measuring characteristics of a work piece and determining which preferred predetermined processing recipe to use for processing the work piece.

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BACKGROUND INFORMATION

Laser processing, such as micromachining, can be conducted on numerous different work pieces using various lasers effecting a variety of processes. For example, lasers are used to drill vias in and ablate material from electronic materials products, such as homogenous films, particulate filled resins, polyimides, and fiber reinforced polymers, either with or without metal cladding.

A goal of laser micromachining operations is to provide consistent quality of laser micromachined features from work piece to work piece and over an entire work piece. In general, the quality of a laser-processed material refers to a standard of excellence specified by a customer of laser processing equipment. Quality metrics differ for different laser processing operations. Some measures which define feature quality include the location, size, and shape of the feature. Other measures include sidewall angle, bottom texture, the amount of cracking near the edge of the feature, as well as the volume and texture of debris left in the feature after micromachining.

One problem with laser micromachining operations as discussed herein is that, due to non-uniformities in the work pieces, performing the machining operations with the same laser parameters on two different work pieces or at two different locations on the work piece can result in differences in feature qualities. Examples of work piece differences that influence the results include differences in thickness, differences in work piece flatness, and differences in surface preparation that makes the work piece more or less reflective of laser power. These variations are not constant from work piece to work piece or over an entire work piece and can vary depending upon location down to an individual feature. However, in some cases, these variations can be repetitive from work piece to work piece in a given lot of work pieces due to normal variations in manufacturing tolerances.

To address part of this problem, the thickness of a work piece is measured and a operator manually determines what laser processing recipe should be used. The user then conveys the recipe to the laser processing system.

SUMMARY OF THE DISCLOSURE

To better address these problems, one or more characteristics are measured from a work piece. The measurement information is used to select a preferred predetermined laser processing recipe from a lookup table. The laser processing recipe is then used to process the work piece.

The lookup table of laser processing recipes can be established from theoretical calculations, from trial an error by an operator, from an automated systematic recipe variation process with post process testing, or from some combination of these or other methods.

An automated process can also reduce operator errors and may store measurement values for convenient tracking of work piece characteristics.

Additional objects and advantages of this invention will be apparent from the following detailed description of preferred embodiments thereof, which proceeds with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partly schematic diagram of an integrated laser micromachining system including a laser system, an automatic loading system, and a measurement system.

FIG. **2**A is a generic recipe selection table.

FIG. **2**B is an exemplary recipe selection table used on a 5330 Laser Via Drilling System.

FIG. **3** is an exemplary recipe that may be associated with a measurement value.

FIG. **4** is a flow diagram of an exemplary loading, measuring, laser micromachining, and unloading process.

FIG. **5** is a side elevation view demonstrating how an exemplary measurement system component can obtain a zero reference focus value.

FIG. **6** is a side elevation view demonstrating how an exemplary measurement system component can obtain a thickness value by determining the change in focus from the zero reference focus value.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. **1** is a partly schematic diagram of an integrated laser micromachining system **10** including a laser processing system **12**, an automatic loading system **14**, and a measurement system **16**. Laser processing system **12** is discussed herein only by way of example to a via drilling system such as for the laser processing of a single or multilayer work piece on a semiconductor wafer or printed circuit board (PCB) panel to effect through hole and/or blind via formation. Skilled persons will appreciate that the laser processing methods described herein could also be applied to any type of laser micromachining, including but not limited to ablative patterning of microstructures, trimming passive thick or thin film components, wafer dicing or drilling, or removal of semiconductor links (fuses), and thermal annealing.

In some embodiments, laser processing system **12** includes one or more lasers **18** and a beam and work piece positioning system **20**, represented by beam deflecting mirror **22** and work piece chuck **24**. Exemplary laser processing systems, and via drilling systems in particular, are disclosed in detail in U.S. Pat. Nos. 5,593,606 and 5,841,099 of Owen et al., U.S. Pat. Nos. 6, 407,363 and 6,784,399 of Dunsky et al., U.S. Pat. No. 7,157,038 of Baird et al., U.S. Pat. No. 7,244,906 of Jordens et al., U.S. Pat. Pub. No. 2005-0265408 of Lei et al., and U.S. patent application Ser. No. 11/756,507 of Lei et al., U.S. patent application Ser. No. 12/057,264 of Peng et al. These patents, publications, and applications are herein incorporated by reference. In some embodiments, a preferred laser processing system **12** includes a Model 5330 laser sys-