OPTICAL NEAR-FIELD METROLOGY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/400,627 filed on September 28, 2016, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE DISCLOSURE

1. TECHNICAL FIELD

[0002] The present disclosure relates to the field of optical metrology, and more particularly, to wafer feature scanning with high sensitivity and accuracy for enhancement of optical metrology.

2. DISCUSSION OF RELATED ART

[0003] Accuracy and sensitivity requirements in optical metrology keep rising with the advances in lithography production technologies and the reduction in integrated circuit (IC) device feature sizes. Current scanning technologies are too slow, too expensive and/or not accurate enough to provide required wafer topography inputs to the optical metrology systems.

SUMMARY OF THE DISCLOSURE

[0004] The following is a simplified summary providing an initial understanding of the disclosure. The summary does not necessarily identify key elements nor limit the scope of the disclosure, but merely serves as an introduction to the following description.

[0005] One aspect of the present disclosure provides a system comprising at least one optical microcavity sensor configured to detect features on a wafer, and a controller configured to measure distances between features of device and features of overlay targets by moving the at least one optical microcavity sensor therebetween.

[0006] These, additional, and/or other aspects and/or advantages of the present disclosure are set forth in the detailed description which follows; possibly inferable from the detailed description; and/or learnable by practice of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] For a better understanding of embodiments of the disclosure and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings in which like numerals designate corresponding elements or sections throughout.

[0008] In the accompanying drawings:

[0009] Figure 1 is a high level schematic illustration of a section of a wafer having multiple layers that include features of devices and features of metrology target(s), according to some embodiments of the disclosure.

[0010] Figures 2 and **3** are high level schematic illustrations of a system configured to measure accurate relative positions of wafer features using optical microcavity sensor(s), according to some embodiments of the disclosure.

[0011] Figure 4 is a high level flowchart illustrating a method, according to some embodiments of the disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0012] In the following description, various aspects of the present disclosure are described. For purposes of explanation, specific configurations and details are set forth in order to provide a thorough understanding of the present disclosure. However, it will also be apparent to one skilled in the art that the present disclosure may be practiced without the specific details presented herein. Furthermore, well known features may have been omitted or simplified in order not to obscure the present disclosure. With specific reference to the drawings, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the present disclosure only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the disclosure. In this regard, no attempt is made to show structural details of the disclosure in more detail than is necessary for a fundamental understanding of the disclosure, the description taken with the drawings making apparent to those skilled in the art how the several forms of the disclosure may be embodied in practice.

[0013] Before at least one embodiment of the disclosure is explained in detail, it is to be understood that the disclosure is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The disclosure is applicable to other embodiments that may be practiced or carried out in various ways as well as to combinations of the disclosed embodiments. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

[0014] Unless specifically stated otherwise, as apparent from the following discussions, it is appreciated that throughout the specification discussions utilizing terms such as "processing," "computing," "calculating," "determining," "enhancing," or the like, refer to the action and/or processes of a computer or computing system, or similar electronic computing device, that manipulates and/or transforms data represented as physical, such as electronic, quantities within the computing system's registers, and/or memories into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission, or display devices.

[0015] Systems and methods are provided which utilize optical microcavity probes to map wafer topography by near-field interactions therebetween in a manner which complies with high volume metrology requirements. The optical microcavity probes detect features on a wafer by shifts in an interference signal between reference radiation and near-field interactions of radiation in the microcavities and wafer features, such as device features and metrology target features. Various illumination and detection configurations provide quick and sensitive signals which are used to enhance optical metrology measurements with respect to their accuracy and sensitivity. The optical microcavity probes may be scanned at a controlled height and position with respect to the wafer and provide information concerning the spatial relations between device and target features.

[0016] **Figure 1** is a high level schematic illustration of a section of a wafer **60** having multiple layers **70** that include features **65** of devices and features **80** of metrology target(s), according to some embodiments of the disclosure. Metrology targets are generally designed to provide data at optical resolution concerning metrology parameters

such as overlay between layers **70**. These data are used as proxy for corresponding data concerning device features **65**, which cannot be measured optically. Features **65**, **80** may comprise any structure or element of corresponding IC devices and metrology targets, respectively (e.g., bars, trenches, or any other structural element). The two double headed arrows illustrate schematically that device features **65** and target features **80** appear in multiple layers of wafer **60**.

[0017] Target features **65** typically suffer from pattern placement error which can be one of the most crucial parameters to be controlled during fabrication of Integrated Circuits (IC) in the semiconductor industry, as the relative positions of the features **65** affect both quality and yield of the final product. Typical patterning dimensions are too small for direct optical resolution, and thus special "proxy" targets are commonly fabricated in every lithography step, and the overlay (as a non-limiting example for a metrology parameter) between these larger "proxy" targets is monitored by various optical technologies.

[0018] However, the accuracy of the correspondence between placement data for device features **65** and target features **80** depends, among others, on (i) the assumption that the positions of features **80** of the metrology target(s) correctly represent the positions of features **65** of corresponding devices and therefore that the misplacements of features **80**, **65** correspond; (ii) the assumption that a distance **85** (indicated schematically) between device features **65** and target features **80** does not introduce additional error; and (iii) the production accuracy of features **80** the metrology target(s) represent. These assumptions are becoming less accurate as the downscale of lithography reaches sub-10nm dimensions. For example, overlay measurements may be unable to tolerate non-zero (e.g., few nm) offsets between features **80** of the overlay targets and features **65** of the actual IC components. As a result, precise calibration is required between placement errors of features **80**, **65**, which are designed at two different length-scales (e.g., 1-10nm versus 100-1000nm).

[0019] **Figure 2** and **3** are high level schematic illustrations of a system **100** configured to measure accurate relative positions of wafer features **65**, **80** using optical microcavity sensor(s) **110**, according to some embodiments of the disclosure.

[0020] System **100** may comprise at least one optical microcavity sensor **110**, comprising coupled microcavity **112** and fiber **114** (e.g., microcavity **112** may be coupled to tapered fiber **114**), configured to detect features on wafer **60**, and a controller **150** configured to measure distances **85** between features **65** of device and features **80** of overlay targets by moving at least one optical microcavity sensor **110** therebetween. For example, as microcavity sensor **110** is scanned (**151A**) above wafer **60**, an evanescent part **112B** of a cavity mode **112A** may interact and seize to interact with on-wafer topography such as features **65**, **80** during scanning **151A**. Thus, the evanescent part of the cavity mode **112A** may extend beyond the microcavity **112** but it does not propagate from the microcavity **112** to outside the microcavity **112**, and its intensity decays exponentially with the distance from the microcavity **112**. This electromagnetic field may have a small extant (e.g., for microcavities approximately 300nm in diameter and distance decay length of approximately 100nm). So if the microcavity **112** is scanned above wafer, the features having topography will get into the region of strong evanescent field and moving away from the microcavity **112** will exit this area (i.e., seize to interact). Microcavity **112** and/or microcavity sensor **110** may be configured thereby to provide radiation which is indicative of the interaction between an evanescent field of the microcavity **112** and the detected features. Cavity mode **112A** can refer to the electromagnetic field within and/or around the microcavity **112**.

[0021] The microcavity **112** may be coupled with the fiber **114** such that the fiber **114** is situated close enough to the microcavity **112** to provide the desired operation. The coupling can occur by tunneling of electromagnetic field between the two areas of high refractive index (e.g., the fiber **114** and microcavity **112**).

[0022] In an instance, the microcavity **112** has total extant of approximately 10μm×500nm. The field (interaction area) is a series of spots with distance of approximately 330nm and diameter of approximately 280nm each. Other dimensions are possible. In this instance, the microcavity **112** is made of silicon and wavelength was 1550nm. Light may be coupled into and from the microcavity **112**.

[0023] Controller **150** may be further configured to carry out the distance measurements layer by layer on wafer **60** to provide accurate measurements of relative position between overlay targets and features **80** in a particular layer, and features **65** or parts of IC

components fabricated in the same layer, and possibly to provide distance calibration for consecutive wafer layers or to provide corrections and enhance the accuracy of optical overlay measurements. For example, system **100** may be configured to provide calibration data concerning the production accuracy of features **80** of metrology target(s), which may then be used in the overlay algorithms to increase the metrology measurements accuracy.

[0024] Optical microcavities are optical resonators which have very narrow transmission (reflection) lines due to the micrometer or even nanometer dimensions of the microcavity (see example in graph **105**). The ratio of an optical frequency ν to transmitted (reflected) bandwidth δ, termed quality factor $Q = \frac{\nu}{\delta}$, may reach values of $Q \cong 10^5 - 10^6$ which enables rapid scanning of the wafer surface. For example, using an optical frequency of $\nu = \frac{c}{\lambda=1550\text{nm}} = 194\text{THz}$ provides $\delta \cong 200\text{MHz}$ which corresponds to a transmission bandwidth of $\delta\lambda \cong 1.55\text{pm}$ (**105B**).

[0025] The shift of the resonance line of microcavity **112** may be calculated using **Equation 1**, with $\delta\lambda_r$ (**105A**) denoting the shift of resonance frequency due to interaction of cavity **112** with IC or target components such as features **65** or **80**, respectively; λ_r denotes the resonance frequency of unperturbed cavity **112**; $E_m(\vec{r})$ denotes the electric field of cavity mode **112**; ϵ and $\delta\epsilon$ denote the electric permittivity and change difference between electric permittivity of IC or target component **65**, **80** and the surrounding medium, respectively; V_p denotes the interaction volume and V denotes the whole space.

$$\frac{\delta\lambda_r}{\lambda_r} = \frac{\int_{V_p} \delta\epsilon |E_m(\vec{r})|^2 dv}{\int_V \epsilon |E_m(\vec{r})|^2 dv} \quad \textbf{Equation 1}$$

[0026] In order to assess the detectability of the frequency shift, it may be compared to transmission bandwidth, as expressed in **Equation 2** (see the definition of Q above).

$$\frac{\delta\lambda_r}{\delta\lambda} = Q \times \frac{\int_{V_p} \delta\epsilon |E_m(\vec{r})|^2 dV_p}{\int_V \epsilon |E_m(\vec{r})|^2 dV} \quad \textbf{Equation 2}$$

[0027] For example, in simulations the sensitivity of $(\delta\lambda_r)/\delta\lambda$ was about 10% per nm of lateral scan (see illustration in graph **105**), while the closest vertical distance of microcavity **112** to on-wafer topography which was simulated was 100nm, indicating the

high sensitivity of disclosed system **100** at reasonable non-limiting measurement conditions.

[0028] As illustrated schematically in **Figure 2**, optical microcavity sensor **110** may be used for scanning probe microscopy. Near field interaction of an evanescent part (indicated schematically by numeral **112B**) of cavity modes (indicated schematically by numeral **112A**) with features **65** and/or **80** on wafer **60** affects the resonance frequency in microcavity **112** of optical microcavity sensor **110** to change (**105A**) the interference wavelength between radiation **112A, B** in microcavity **112** and radiation **114A** in coupled fiber **114**, as shown schematically in graph **105**. A controller **150**, e.g., via a position control module **151**, may be configured to control a horizontal position (indicated schematically by an arrow **151A**) of at least one optical microcavity sensor **110**, to provide mapping of the topography at the current layer across wafer **60**.

[0029] Advantageously, microcavity sensors **110** may be designed to have a confined intensity distribution by configuring a small mode volume, and further designed to store a significant part of the optical energy in evanescent waves **112B** which may extend beyond the physical extent of sensor **110** (illustrated schematically in **Figure 2** with respect to microcavity **112**) to provide enhanced sensitivity. These configurations may be adjusted to provide efficient interaction of microcavity **112** with its surroundings and provide high measurement resolution.

[0030] In certain embodiments, optical microcavities **112** of sensors **110** may be, as non-limiting examples, micro-toroids, micro spheres, micro discs, 1D or 2D (one or two dimensional) photonic crystal cavities, nano-beam cavities, or any other configuration which yields high quality factors and tight confinement of the optical energy. For example, quality factor is used to measure the microcavities **112**. In an instance, a high quality factor is $Q>100$ and tight confinement means less than λ^3.

[0031] Coupling mechanisms of microcavities **112** to fiber **114** may comprise, for example, direct (grating) coupling of cavity modes **112A** to external laser field; coupling to tapered fiber **114**; and/or evanescent coupling to a waveguide or a prism.

[0032] Figure 3 illustrates schematically configurations of system **100**, according to some embodiments of the disclosure. The illustrated elements may be employed singly or in various combinations with other elements.

[0033] Resonance shift detection (detection of $\delta\lambda_r$ **105A**) **130** may be carried out in any of the following non-limiting examples. (i) Broadband illumination source **120** with spectrally sensitive detection **130** (e.g., using a high resolution spectrometer), which may provide immediate detection of line-shift, but might be limiting in terms of readout speed. (ii) Using a tunable light source illumination **120** with a photodetector may provide detection **130** of transmitted intensity as function of illumination wavelength at every scan point. (iii) Illumination **120** with a fixed narrow linewidth tuned to the transmission line slope (**105C** in **Figure 2**) and detection **130** with a fast photodetector, to provide intensity detection at every scan point. Any of illumination sources **120** may, in some embodiments, be also controlled by controller **150**, such as to tune the illumination provided thereby.

[0034] In certain embodiments, sensor **110** and/or microcavity **112** may be loaded with a broad–bandwidth fluorescent medium **140** which may be configured to enhance the sensitivity of sensor **110**, provide a specified optical gain in a range covered by cavity resonance, and/or enhance the detectability of interactions between cavity **112** and features **65**, **80**. In certain embodiments, microcavity **112** may be configured as a high Q cavity loaded with fluorescent medium **140** and have a narrowband emission spectrum (similar to a laser, with corresponding optical gain). The interaction of disclosed microcavity **112** with on-wafer features **65**, **80** may change the emitted spectrum via effective modification of resonant conditions of cavity **112**.

[0035] For example, a laser can function by inclusion of fluorescent medium **140**, such as indium phosphide, within a microcavity **112**. The fluorescent medium **140** is excited by means of external energy supply (e.g., an electric current) and emits light. In general, fluorescent medium **140** can emit a broad spectrum, but once such emission happens in a microcavity **112**, the emission will occur within the cavity mode and the wavelength will be defined by microcavity **112** geometry and properties (e.g., due to the Purcell effect). Perturbation of the microcavity **112** by interaction with on-wafer features will change resonance of the microcavity **112** and, thus, will change the emitted wavelength.

[0036] In certain embodiments, controller **150** may be further configured and/or comprise a height module **152** configured to control a vertical position of microcavity(ies) **112**. Controller **150** and/or **152** may be further configured to maintain microcavity(ies) **112** at

a specified scanning height. Multiple wafers **60** may be scanned by system **100**, possibly at a fixed height above wafers **60**, with controller **150** detecting and adjusting for wafer-to-wafer variations in optical and/or topographic properties, such as by comparing location-specific optical signals detected by sensor(s) **110** and/or sensor(s) **155**. For example, the vertical position may be approximately 100 nm or less from the surface of the wafer **60**, though other dimensions are possible.

[0037] In certain embodiments, system **100** may comprise at least one auxiliary optical microcavity sensor **155** configured to provide scanning height data to controller **150** and/or **152**. Such configurations may extend the applications of sensor **110** to provide relative comparison between optical responses of different wafers while keeping scan height constant with the feedback from auxiliary optical microcavity sensor(s) **155** or other proximity sensors.

[0038] In certain embodiments, a microcavity signal **111** (illustrated schematically and denoted by numeral **111**, e.g., corresponding to analysis results of graph **105**) may be cross-registered with the optical metrology signals. For example, optical microcavities **112** and/or optical microcavity sensors **110** having typical sizes of 1-20μm may be mounted on a transparent substrate **115** and introduced (e.g., as an entire scanning head) into the working distance between an optical objective **90** and wafer **60**. In certain embodiments, transparent substrate **115** may further comprise printed registration marks **115A** (shown schematically) for registering the optical metrology measurement with microcavity sensor(s) **100** and simultaneously collecting signal(s) **111** from microcavity sensor(s) **100** to further enhance metrology measurement accuracy.

[0039] **Figure 4** is a high level flowchart illustrating a method **200**, according to some embodiments of the disclosure. The method stages may be carried out with respect to system **100** described above, which may optionally be configured to implement method **200**. Method **200** may be at least partially implemented by at least one computer processor, e.g., in a metrology module. Certain embodiments comprise computer program products comprising a computer readable storage medium having computer readable program embodied therewith and configured to carry out the relevant stages of method **200**. These method stages are described in more detail with respect to system **100** described above and optionally configured to implement method **200**.

[0040] Method **200** may comprise using optical microcavity probes, such as microcavities **112** and/or microcavity sensors **110**, to map the wafer topography by near-field interactions affecting resonance frequency (stage **205**), and possibly configuring the illumination and detection to comply with high volume metrology requirements (stage **210**). For example, the optical microcavity probes comprise microcavities coupled to respective fibers, and method **200** may further comprise configuring the microcavities to provide evanescent radiation extending beyond the respective cavities to interact with wafer features to provide interference with radiation in the fiber.

[0041] Method **200** may comprise any of using broadband illumination and spectrally sensitive detection to detect line shifts directly (stage **212**), using tunable illumination and detecting wavelength dependent intensities (stage **214**), and/or using narrowband illumination at the transmission line slope and detecting the intensity by a fast detector (stage **216**).

[0042] Method **200** may comprise coupling the microcavity with a fluorescent medium to enhance detection (stage **220**).

[0043] Method **200** may comprise monitoring and/or controlling the scanning height of the microcavity probes, such as the distance of the microcavity probes from the wafer structures (stage **230**). In some embodiments, method **200** may comprise using additional optical microcavity probes to monitor the scanning height (stage **235**). Method **200** may comprise further comprise scanning multiple wafers at a fixed height, adjusting for optical and/or topographic variation (stage **237**).

[0044] Method **200** may comprise measuring the position of overlay target structures with respect to device structures (stage **240**) and possibly co-registering the microcavity signal and the optical metrology measurements (stage **250**).

[0045] Advantageously, disclosed systems **100** and methods **200** combine measurement speed and accuracy which are superior to previous methods, such as e-beam imaging, electron microscopy or scanning probe methods (atomic force microscopy, AFM). Moreover, disclosed systems **100** and methods **200** are less prone to errors resulting from local charge which attenuates electrons, distorts the images of electron-based previous imaging systems, and consequently may exhibit significant positioning errors. Finally, disclosed systems **100** and methods **200** require less 3D positioning accuracy than AFM-

based methods and are not limited by cantilever oscillation frequency of the AFM which causes long measurements durations (e.g., for cantilever oscillation frequencies between 10-100kHz, scanning a $1\mu m^2$ area with resolution of $1nm^2$ is approximately 100sec), that are unacceptable for high volume manufacturing (HVM).

[0046] Advantageously, using optical microcavity(ies) as a scanning head for IC circuits enables fast non-contact scanning (e.g., at distances, or heights in the order of magnitude of 100nm), utilizing the fast response of the resonator to reduce the scan time with respect to the prior art by up to eight orders of magnitude. Moreover, systems **100** and methods **200** may be limited only by detector speeds rather than by the oscillator frequency. Initial simulations suggest that disclosed systems **100** and methods **200** may improve the accuracy of overlay measurements and provide overlay measurements which are more robust with respect to process variations. Moreover, disclosed systems **100** and methods **200** enable utilization of scanning probe microscopy for cross registration of IC components to overlay targets and integration of optical microcavity sensing in the scanning head for overlay metrology and possibly also for proximity sensing for feedback on the scanning height.

[0047] Embodiments disclosed herein can provide quick and sensitive signals which are used to enhance optical metrology measurements with respect to their accuracy and sensitivity. For example, scan time can be defined by the time it takes to measure every point multiplied by the number of points to measure because the measurement may be performed point by point. Time to measure a point can be estimated as cavity response time, which is evaluated as approximately optical oscillation time multiplied by a mean number of oscillations it takes for a photon to leave the cavity. This number is called Q-factor, and can be as high as $Q \cong 10^6$. Oscillation time is $\tau_{opt} = \frac{\lambda}{c} = \frac{1.5\times10^{-6}m}{3\times10^{8}\frac{m}{s}} = 5 \times 10^{-15}s.$ $t\,[per\ point] = t_{opt} \times Q = 5nsec.$ To measure a target with dimensions of $1\mu m \times 1\mu m$ with resolution of $1nm \times 1nm$, it may make it 1 million points, so total nominal measurement time will be approximately 5 millisecond. Such an estimation does not take into account any mechanical overhead.

[0048] Aspects of the present disclosure are described above with reference to flowchart illustrations and/or portion diagrams of methods, apparatus (systems), and computer

program products according to embodiments of the disclosure. It will be understood that each portion of the flowchart illustrations and/or portion diagrams, and combinations of portions in the flowchart illustrations and/or portion diagrams, can be implemented by computer program instructions. These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or portion diagram or portions thereof.

[0049] These computer program instructions may also be stored in a computer readable medium that can direct a computer, other programmable data processing apparatus, or other devices to function in a particular manner, such that the instructions stored in the computer readable medium produce an article of manufacture including instructions which implement the function/act specified in the flowchart and/or portion diagram or portions thereof.

[0050] The computer program instructions may also be loaded onto a computer, other programmable data processing apparatus, or other devices to cause a series of operational steps to be performed on the computer, other programmable apparatus or other devices to produce a computer implemented process such that the instructions which execute on the computer or other programmable apparatus provide processes for implementing the functions/acts specified in the flowchart and/or portion diagram or portions thereof.

[0051] The aforementioned flowchart and diagrams illustrate the architecture, functionality, and operation of possible implementations of systems, methods and computer program products according to various embodiments of the present disclosure. In this regard, each portion in the flowchart or portion diagrams may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing the specified logical function(s). It should also be noted that, in some alternative implementations, the functions noted in the portion may occur out of the order noted in the figures. For example, two portions shown in succession may, in fact, be executed substantially concurrently, or the portions may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each

portion of the portion diagrams and/or flowchart illustration, and combinations of portions in the portion diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and computer instructions.

[0052] In the above description, an embodiment is an example or implementation of the disclosure. The various appearances of "one embodiment," "an embodiment," "certain embodiments," or "some embodiments" do not necessarily all refer to the same embodiments. Although various features of the disclosure may be described in the context of a single embodiment, the features may also be provided separately or in any suitable combination. Conversely, although the disclosure may be described herein in the context of separate embodiments for clarity, the disclosure may also be implemented in a single embodiment. Certain embodiments of the disclosure may include features from different embodiments disclosed above, and certain embodiments may incorporate elements from other embodiments disclosed above. The disclosure of elements of the disclosure in the context of a specific embodiment is not to be taken as limiting their use in the specific embodiment alone. Furthermore, it is to be understood that the disclosure can be carried out or practiced in various ways and that the disclosure can be implemented in certain embodiments other than the ones outlined in the description above.

[0053] The disclosure is not limited to those diagrams or to the corresponding descriptions. For example, flow need not move through each illustrated box or state, or in exactly the same order as illustrated and described. Meanings of technical and scientific terms used herein are to be commonly understood as by one of ordinary skill in the art to which the disclosure belongs, unless otherwise defined. While the disclosure has been described with respect to a limited number of embodiments, these should not be construed as limitations on the scope of the disclosure, but rather as exemplifications of some of the preferred embodiments. Other possible variations, modifications, and applications are also within the scope of the disclosure. Accordingly, the scope of the disclosure should not be limited by what has thus far been described, but by the appended claims and their legal equivalents.

CLAIMS

1. A system comprising:

at least one optical microcavity sensor configured to detect features on a wafer, and

a controller configured to measure distances between features of device and features of overlay targets by moving the at least one optical microcavity sensor therebetween.

2. The system of claim 1, wherein the at least one optical microcavity sensor comprises at least one microcavity configured to provide evanescent radiation extending beyond the at least one microcavity and to interact with the detected features, and wherein the at least one microcavity is further configured to provide radiation which is indicative of interaction between an evanescent field of the at least one microcavity and the detected features.

3. The system of claim 2, wherein the at least one microcavity is configured to yield a high quality factor greater than 100 and a tight confinement of optical energy less than λ^3 in the at least one microcavity.

4. The system of claim 3, wherein the at least one microcavity is formed as a micro- toroid, a micro sphere, a micro disc, or a ID or 2D (one or two dimensional) photonic crystal cavity.

5. The system of claim 1, wherein the controller is further configured to control a horizontal position of the at least one optical microcavity sensor.

6. The system of claim 1, wherein the controller is further configured to control a vertical position of the at least one optical microcavity sensor.

7. The system of claim 6, wherein the controller is further configured to maintain the at least one optical microcavity sensor at a specified scanning height.

8. The system of claim 6, further comprising at least one auxiliary optical microcavity sensor configured to provide scanning height data to the controller.

9. A method comprising:

using optical microcavity probes to map a wafer topography by near-field interactions therebetween, and

configuring illumination to and detection by the optical microcavity probes to perform high volume metrology.

10. The method of claim 9, further comprising using broadband illumination and spectrally sensitive detection to directly detect line shifts sensed by the optical microcavity probes.

11. The method of claim 9, further comprising using tunable illumination and detecting wavelength-dependent intensities of signals from the optical microcavity probes.

12. The method of claim 9, further comprising using narrowband illumination at a transmission line slope of the optical microcavity probes and detecting a signal intensity thereof by a fast detector.

13. The method of claim 9, wherein the optical microcavity probes comprise microcavities coupled to respective fibers, the method further comprising configuring the microcavities to provide evanescent radiation extending beyond the respective cavities to interact with wafer features provide interference with radiation in the fiber.

14. The method of claim 9, further comprising controlling a scanning height of the microcavity probes.

15. The method of claim 14, further comprising scanning multiple wafers at a fixed scanning height, adjusting for optical and/or topographic variation of the wafers.

16. The method of claim 9, further comprising measuring a position of overlay target structures with respect to device structures in the wafer topography.

17. The method of claim 16, further comprising co-registering signals from the optical microcavity probes and corresponding optical metrology measurements.