

THICKNESS MEASUREMENT TECHNIQUE FOR MULTI-LAYER THIN FILMS AND SUBSTRATE SIMULTANEOUSLY BASED ON HYBRID TECHNOLOGY

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TECHNICAL FIELD OF THE INVENTION

The present invention relates to a tool capable of measuring thicknesses of thin-film and substrate material that are essential in the semiconductor and display industries.

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BACKGROUND OF THE INVENTION

To produce multi-functional devices, thin film deposition procedures on a substrate are essential in the semiconductor and display industries. In most of these applications, the device performance is directly dependent on the thickness of the thin film coated, as well as its thickness uniformity. It is essential to measure the physical thicknesses of the thin film and substrate at the same time to prevent yield reduction and performance degradation of such devices. Additionally, simultaneous measurements will improve the quality of sidewall or hole patterning procedures.

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The range of substrate thickness varies from a few hundred micrometres to a few millimetres, compared to, from a few nanometres to a few micrometres for thin film coatings. The simultaneous thickness measurements of thin film and substrate are difficult due to the wide range of thicknesses. This issue becomes severe when the substrate to thin film thickness ratio exceeds 10^6 and cannot be measured with current technologies. Therefore, there is a need for a tool capable of measuring the thicknesses of thin films and substrates, as the materials exceed 10^6 ratios in the semiconductor and display industries.

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Measurement range limitations caused by the optical characteristics of individual measurement techniques like spectroscopic ellipsometry (SE) and spectroscopic reflectometry (SR) force industries to use these separately for thickness measurements. Due to differences in measurement principles and time resolution, it is hard to perform simultaneous

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measurements using spectroscopic reflectometry (SR) and spectroscopic ellipsometry (SE) techniques. For a simple configuration and rapid measurement, spectroscopic reflectometry (SR) can be applied to thin-film thickness measurements exceeding a few tens of nanometres. In the case of substrate thickness measurement, various optical techniques, like low-coherence interferometry (LCI), chromatic confocal microscopy (CCM), and spectral interferometry (SI) have been widely used. Since spectral interferometry (SI) determines the thickness by analysing the spectral phase acquired without any scanning, it is superior in substrate measurement. Successful integration of these technologies can solve the measurement range issues. Various optical requirements need to be fulfilled by design before the integrated measurement system like the coupling, separation and processing of different sets of acquired spectral information, optical path sharing, and beam shape matching. The proposed method of the present invention can be exploited as a hybrid metrological tool capable of thickness measurements in a wide dynamic range in the semiconductor and display industries.

SUMMARY OF THE INVENTION

The present invention may be embodied in other specific forms without departing from its essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore indicated by the appended claims rather than by the foregoing description. All changes, which come within the meaning and range of equivalency of the claims, are to be embraced within their scope.

The present invention describes a method for measuring a thickness of a sample, comprising steps of setting a sample on a sample holder having a translation stage and illuminating a target area of a surface of the sample using a light source, and applying one or more changeable filters according to the material and thickness of the sample. The methods also include detecting a reflected signal intensity spectrum with and without the sample on the sample holder using a visible-light spectrometer, and detecting an interference signal intensity spectrum from the sample on the sample holder using an near-infrared light wavelength-based spectrometer. Also, the methods include obtaining an optical path difference (OPD) of each layer from the sample on the sample holder using the near-infrared light wavelength-based spectrometer and fusing data from the visible-light spectrometer and the NIR light

wavelength-based spectrometer for obtaining the sample thickness by a processing module stored in a computer-readable medium that is connected to the visible-light spectrometer and the near-infrared light wavelength-based spectrometer.

- 5 This method is characterized in that the processing module comprises of methods for fusing the OPD of each layer for obtaining the thickness of the sample.

Further, a theoretical reflectance and interference spectrum is obtained from known parameters while an experimental reflectance spectrum is obtained from the reflected signal
10 intensity spectrum.

Further, the thickness of the sample is obtained by fitting the theoretical and experimental reflectance spectrum through a Levenberg-Marquardt algorithm.

- 15 Further, an experimental interference spectrum is obtained from the intensity spectrum data and the Optical Path Difference (OPD) of up to two layers where each layer is obtained by separating the frequency peaks of the experimental interference spectra using Fourier transform.

- 20 Further, the thickness of the first layer is obtained from the three OPDs that are specified according to the layers and the refractive index of the first layer is obtained from the second OPD and thickness of the first layer.

Further, the thickness of the second layer is obtained from the interferences of two OPD and
25 the refractive index of the first layer while the refractive index of the second layer is obtained from the OPD of the second layer and the OPD of the third layer.

Further, the thickness of the first layer is obtained from the OPDs.

- 30 The present invention also describes a system for measuring a thickness of a sample, comprising a light source configured for emitting a beam of light illumination comprising multiple wavelengths towards the sample and a changeable filter positioned between one or more collimation lenses and a first dichroic mirror for allowing a selection of specific

wavelength bands to pass through based on the sample material and thickness, wherein the first dichroic mirror is positioned between the changeable filter and a first beam splitter for transmitting light with a wavelength of less than 700 nm while reflecting light with a wavelength of more than 800 nm. A second focusing lens is positioned between the first beam splitter and a visible-light spectrometer, wherein the first beam splitter is positioned preferably at an angle to the first dichroic mirror for directing the light into separate paths for a visible-light spectrometer and a NIR light wavelength-based spectrometer, respectively, and a second dichroic mirror positioned preferably at a right angle to a sample holder and a second beam splitter for transmitting the light from the collinear first beam splitter and for reflecting the light from the second beam splitter, wherein the second beam splitter for dividing the light into a reference path to a third dichroic mirror and a signal path to the second dichroic mirror is positioned preferably at a right angle to the first dichroic mirror and the second dichroic mirror. A third beam splitter is positioned preferably at a right angle between the third dichroic mirror and the sample holder for reflecting light signal from the sample holder and for transmitting the light of the reference path from the third dichroic mirror, wherein a first focusing lens for controlling the width of the spectrometer is positioned between the third beam splitter and the NIR light wavelength-based spectrometer. Also, a processor is connected to the visible-light spectrometer and the NIR light wavelength-based spectrometer for analyzing the reflected light and determining the reflectance of the sample.

The system of the present invention is characterized in that the system further comprises a single broadband light source, a visible-light spectrometer, and a NIR light wavelength-based spectrometer, wherein the visible-light spectrometer captures the light signal with visible wavelength and the NIR light wavelength-based spectrometer captures the light signal with NIR wavelength from the light source with a wide range of wavelength.

Preferably, the light source comprises multiple light-emitting diodes (LEDs) emitting light at a wide range of wavelengths.

Further, the visible-light spectrometer detects the intensity and wavelength characteristics of reflected light after passing through the first focusing lens from the first beam splitter.

Further, the NIR light wavelength-based spectrometer separate the combined reference and signal beams from the third beam splitter.

Preferably, the changeable filters comprise amounts that correspond to the materials and thickness of the samples under investigation.

Further, the sample holder further comprises a translation stage in X, Y, and Z directions for holding the sample for accurate coverage of the transmitted light and reflected light from the second dichroic mirror.

BRIEF DESCRIPTION OF THE DRAWINGS

To further clarify various aspects of some embodiments of the present invention, a more particular description of the invention will be rendered by references to specific embodiments thereof, which are illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail through the accompanying drawings in which:

Figure 1 illustrates a system setup diagram of a hybrid metrology tool of the present invention.

Figure 2 illustrates a flowchart related to the signal acquisition and fusion algorithm of the present invention.

Figure 3 illustrates a flowchart related to the working of the spectroscopic reflectometry (SR) based thickness measurement algorithm of the present invention.

Figure 4 illustrates a flowchart related to the working of the spectral interferometry (SI) based thickness measurement algorithm of the present invention.

Figure 5 illustrates a flowchart related to the measurement procedure of the refractive indices and thicknesses using spectral interferometry (SI) of the present invention.

5 DETAILED DESCRIPTION OF THE INVENTION

The present invention is a unique hybrid tool capable of measuring thicknesses of thin film and substrate, materials that possess large variations in thickness range simultaneously. The integration of technologies like spectral reflectometry and spectral interferometry have been used to realize the novel measurement establishment. Keeping both the measurement accuracy and hardware simplicity have been achieved by providing a single illumination path and a broadband illumination source with the help of the dichroic mirrors, filters etc. to divide the wavelength bands and also separate the signals from the sample to the spectrometers (*visible wavelength* [wavelength range : 380 to 700 nm] and *NIR* [wavelength range : 800 to 2,500 nm]) based detection system working along with an advanced algorithm for signal acquisition and data fusion. A measurement range of sub nanometre to millimetre level can be covered with the hybrid metrology tool. Factors like configuration flexibility, measurement speed, measurement range, and measurement precision are taken into consideration for selecting techniques like spectroscopic reflectometry (SR) and spectral interferometry (SI).

20 Spectral Reflectometry (SR)

Spectroscopic reflectometry is a film metrology technique that allows faster measurement and data acquisition. SR film thickness measurement measures the reflectance of a sample using multiple wavelengths of light available for wavelength selection and calculates film thickness by fitting the data with an optical model. Spectral reflectance measures the amount of light reflected from a thin film over a range of wavelengths, with the incident light normal to the sample surface. The thin-film thickness is determined by fitting the plot of the theoretical reflectance spectrum to the experimental reflectance spectrum. The theoretical reflectance of the thin-film specimen is calculated by modelling multiple reflections at both interfaces of the thin-film layer. Experimental reflectance is the ratio of the reflected beam from an unknown sample to a known sample which multiplies with reference reflectance. Reflected signals from

each point are collected and the reflectance value from each wavelength selection is plotted and fitted with a calculated theoretical reflectance plot to get the corresponding thickness.

Spectral Interferometry (SI)

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Spectral interferometry (SI), also known as frequency-domain interferometry, is a linear technique for measuring the information about the intensity and phase of the optical spectrum. The illumination beam is divided into two and one will act as the reference beam and the other will pass through the sample. Then, both spectrums will interfere together to form fringes. The unknown pulses with a path length difference can be retrieved from the interference signal detected. The period of interference spectrum has been influenced by the Optical Path Difference (OPD). It can be calculated by multiplying the peak position after the Fourier transform of the interference spectrum in the frequency domain and the speed of light in a vacuum. The interference spectrum generated through the interference between only four measurement beams (B1, B2, B3, and B4) was transmitted through the thin-film specimen, which were selected based on optical intensity. The measurement procedure is included as a detailed flowchart in figure 5.

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Figure 1 illustrates the system setup of the Spectroscopic Reflectometry-Spectral Interferometry (SR-SI) hybrid metrology tool. A single broadband light source has been arranged in the system setup. Dichroic mirrors and changeable filters are positioned in the illumination path to separate different wavelength bands based on different material samples and thicknesses. Spectroscopic reflectometry (SR) based system works under visible wavelength range and the signal reflected from the sample is collected back in the same path with opposite directions with a visible-light spectrometer (visible wavelength). In the case of spectral interferometry (SI) based measurement, the illumination light is under near-infrared light (NIR wavelength range: 800 to 2,500 nm) region. It is separated to reference and signal light paths using beam splitters, to achieve interference after passing through sample material fixed on the sample holder having a translation stage. This interference spectrum is collected to a near-infrared light (NIR) wavelength-based spectrometer and signals have been separated for analysis.

The reference interference spectrum and the measured one are collected, respectively using with and without samples. For an efficient analysis and fitting between the two interference spectra, both data sets with different envelopes are normalized to the same scale. The signal analysis, thickness measurement and data fusion are carried out with the help of advanced algorithms packaged in a processing module that is stored in a computer-readable medium connected to the visible-light spectrometer and the NIR light wavelength-based spectrometer. The thickness of the sample is obtained by fusing the OPD of each layer through the advanced processing module. The measurement process is described in figures 2, 3, 4, and 5 through flowcharts.

Working of the hybrid tool is described, as follows:

- Broadband Illumination:

A single broadband light source (1) comprising multiple light-emitting diodes (LEDs) is used to provide a wide range of wavelengths for illuminating the sample. The light emitted by the source is collimated using lenses (2a-b) to ensure a parallel beam.

- Beam Expansion:

Lenses (2a-b) are placed after the light source (1) to expand the beam diameter, providing sufficient coverage over the sample area.

- Wavelength Selection:

The collimated light passes through changeable filters (3) that allow for the selection of specific wavelength bands suited for the desired analysis are positioned between the collimation lenses (2b) and the first dichroic mirror (4a). These filters can be interchanged based on the material samples and thicknesses under investigation.

- Wavelength Separation:

Multiple dichroic mirrors (4a-c) are strategically positioned to separate the incident light into different wavelength bands suitable for both spectroscopic reflectometry (SR) and spectral interferometry (SI) modalities. The dichroic mirrors reflect specific wavelengths while transmitting others, effectively splitting the light into different paths. The first dichroic mirror (4a) that allows selected wavelength bands to pass through is positioned between the changeable filter (3) and the first beam splitter (5a). The second dichroic mirror (4b) that transmits and reflects the light from the first and second beam splitters accordingly is positioned preferably at a right angle to a sample holder (6) and a second beam splitter (5b). The third dichroic mirror (4c) is placed preferably at a right angle between the second beam splitter (5b) and the third beam splitter (5c).

- Light Steering:

The first beam splitter (5a) that is employed to direct the light into separate paths for the SR and SI modalities is positioned preferably at an angle to the first dichroic mirror (4a). The second beam splitter (5b) that divides the incident light into a reference path and a signal path is positioned preferably at a right angle to the first dichroic mirror (4a) and the second dichroic mirror (4b). The third beam splitter (5c) that redirects and transmits the lights from separate paths towards the NIR light wavelength-based spectrometer (9) through the first focusing lens (7a) is positioned preferably at a right angle between the third dichroic mirror (4c) and the sample holder (6).

- Sample Scanning:

The light in the signal path passes through a sample holder equipped with a translation stage (6) in X, Y, and Z directions. The translation stage (6) allows precise scanning of the sample, enabling measurements at different positions or areas of interest.

- Spectroscopic Reflectometry (SR):

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In the SR modality, the signal light reflected from the sample is collected in the same path but in the opposite direction. A visible wavelength spectrometer (8) is placed to acquire the reflected signal focused by a second focusing lens (7b) from the sample. The spectrometer

captures the spectral information, enabling analysis of the reflected light's intensity and wavelength characteristics.

- Spectral Interferometry (SI):

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In the SI modality, the illumination light is in the near-infrared (NIR) wavelength range (800 to 2,500 nm). The light is split into a reference beam and a signal beam using beam splitters (5b). Both beams pass through the sample material fixed on the translation stage (6). Interference occurs between the reference and signal beams when recombined. The interference spectrum is collected using a focusing lens (7a) into a NIR wavelength-based spectrometer (9). The spectrometer separates the interference signals into reference and sample signals for further analysis.

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Algorithm for Signal Acquisition and Data Fusion

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Through figure 2, a general signal acquisition procedure is depicted. A light signal is acquired by two separate detection arms, which include a visible range spectrometer for acquiring spectral reflected signal from known and unknown samples, and an NIR wavelength range spectrometer for acquiring interference spectrum signal data. The model-based reference signal calculation and experimental reflectance and optical path difference calculation have been carried out separately using two independent algorithms, which are illustrated in figures 3, 4 and 5.

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In spectral reflectometry (SR), as per the flowchart in figure 3, the model-based theoretical reflectance is calculated from known parameters (104). The experimental reflectance is calculated from the intensity spectrum data acquired (105). Both of the reflectance values are plotted against wavelength variation. These two plots are fitted by the Levenberg–Marquardt algorithm, which is used to solve non-linear least squares problems. After fitting, the corresponding thickness value used in the theoretical reflectance model is approximated as the thickness for the unknown sample (106).

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The steps are described, as follows:

1. Start the scanning procedure using the translation stage (101).

2. Acquire reflected signal intensity spectrum without any thin film (102).
3. Acquire reflected signal intensity from the thin film sample (103).
4. Calculate theoretical reflectance spectrum feeding parameters (104).
5. Obtain experimental reflectance spectrum from measured intensities (105).
- 5 6. Calculate thin film thickness by taking the differences of values from each position's theoretical and experimental reflectance values (106).

In spectral interferometry (SI), the measurement procedure is carried out by the steps mentioned in figure 4. The model-based theoretical interference spectra are calculated from
 10 known parameters. Experimental interference spectra signal is collected (108) and the Fourier transform is carried out to separate the frequency peaks that directly give the Optical Path Differences (OPD) from each layer (109). Figure 4 illustrates the detailed calculation procedure for parameters from each layer after getting the OPDs. It is an equation-based direct method which solves the parameter values of refractive index (N) and thickness (T) from each
 15 layer. The fitting algorithm approach is also used in this case to compare the values. After collecting the thickness values from both analyses, the data is merged and summation is displayed as per figure 2.

The steps are described, as follows:

- 20 1. Start the scanning procedure using the translation stage (107).
2. Acquire interference signal intensity spectrum with thin film specimen (108).
3. Acquire OPDs of each layer from the thin film sample (109).
4. Calculate experimental interference spectrum feeding parameters from each layer (110).
5. Obtain the total experimental interference spectrum from measured intensities (110).
- 25 6. Calculate thin film thickness by taking the differences of values from each position's theoretical and experimental interference values (111).

Measurement procedure steps of refractive indices and thicknesses using spectral interferometry (SI) algorithm are further described, as follows:

- 30 1. Acquire OPDs such as OPD_1 (112), $OPD_2(x_1)$ (114), and $OPD_3(x_1)$ (113) from each layer (up to 2 layers are described here).
2. Calculate the thickness of the first layer [$T_1(x_1)$] from the OPDs (115).

3. Calculate refractive index (N_1) of first layer (116) from the second OPD [$OPD_2(x_1)$] (114) and thickness of the first layer [$T_1(x_1)$] (115).
 4. Calculate the thickness of the second layer [$T_1(x_2)$] (120) from $OPD_{2,1}(x_2)$ (121) and the refractive index N_1 (116).
 5. Calculate thickness of the second layer [$T_2(x_2)$] (118) from two interference OPDs (117) and N_1 (116).
 6. Calculate refractive index N_2 of second layer (119) from OPD_2 and OPD_3 from the second layer (121) with thickness $T_2(x_2)$ (118).
- 10 The hybrid tool is capable of measuring thicknesses of thin film and substrate, material that possesses large variations in thickness range simultaneously. The integration of technologies like spectral reflectometry (SR) and spectral interferometry (SI) is used to realize this novel measurement establishment. Successful integration of these technologies solves the measurement range issues. Various optical requirements need to be fulfilled by design before
- 15 the integrated measurement system like the coupling, separation, and processing of different sets of acquired spectral information, optical path sharing, and beam shape matching. A measurement range of sub-nanometre to millimetre level can be covered with the proposed tool. The proposed method can be exploited as a hybrid metrological tool capable of thickness measurements in a wide dynamic range in the semiconductor and display industries.
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- The present invention may be embodied in other specific forms without departing from its essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore indicated by the appended claims rather than by the foregoing description. All changes, which come within the
- 25 meaning and range of equivalency of the claims, are to be embraced within their scope.

Reference numerals for the system

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|--------|--------------------------------------|
| (1) | Broadband light source |
| (2a-b) | Collimation lenses |
| 30 (3) | Changeable filter |
| (4a-c) | Dichroic mirrors |
| (5a-c) | Beam splitters |
| (6) | Sample holder with translation stage |

- (7a-b) Focusing lenses
- (8) Spectrometer (Visible)
- (9) Spectrometer (NIR)

CLAIMS

1. A method for measuring a thickness of a sample, comprising steps of:
setting a sample on a sample holder having a translation stage and illuminating a target
5 area of a surface of the sample using a light source;
applying one or more changeable filters according to the material and thickness of the
sample;
detecting a reflected signal intensity spectrum without (102) and with (103) the sample
on the sample holder using a visible-light spectrometer;
10 detecting an interference signal intensity spectrum (108) from the sample on the sample
holder using an near-infrared light wavelength-based spectrometer;
obtaining an optical path difference (OPD) of each layer (109) from the sample on the
sample holder using the near-infrared light wavelength-based spectrometer; and
fusing data from the visible-light spectrometer and the NIR light wavelength-based
15 spectrometer for obtaining the sample thickness (119) by a processing module stored in a
computer-readable medium that is connected to the visible-light spectrometer and the near-
infrared light wavelength-based spectrometer,
characterized in that the processing module comprises methods for fusing the OPD of
each layer for obtaining the thickness of the sample.
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2. The method for measuring a thickness of a sample according to claim 1, wherein a
theoretical reflectance (104) and interference spectrum (110) is obtained from known
parameters.
- 25 3. The method for measuring a thickness of a sample according to claim 1, wherein
an experimental reflectance spectrum (105) is obtained from the reflected signal intensity
spectrum.
4. The method for measuring a thickness of a sample according to claim 1, wherein
30 the thickness of the sample is obtained by fitting the theoretical and experimental reflectance
spectrum through a Levenberg-Marquardt algorithm (106).

5. The method for measuring a thickness of a sample according to claim 1, wherein an experimental interference spectrum (108) is obtained from the intensity spectrum data.

6. The method for measuring a thickness of a sample according to claim 1, wherein
5 the Optical Path Difference (OPD) of up to two layers where each layer is obtained by separating the frequency peaks of the experimental interference spectra using Fourier transform (109).

7. The method for measuring a thickness of a sample according to claim 1, wherein
10 the thickness of the first layer is obtained from the three OPDs that are specified according to the layers (115).

8. The method for measuring a thickness of a sample according to claim 1, wherein
the refractive index of the first layer is obtained from the second OPD and thickness of the
15 first layer (116).

9. The method for measuring a thickness of a sample according to claim 1, wherein
the thickness of the second layer is obtained from the interferences of two OPD and the
refractive index of the first layer (120).

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10. The method for measuring a thickness of a sample according to claim 1, wherein
the refractive index of the second layer is obtained from the OPDs of the second layer (119).

11. The method for measuring a thickness of a sample according to claim 1, wherein
25 the thickness of the first layer is obtained from the OPDs (115).

12. A system for measuring a thickness of a sample, comprising:
a light source (1) configured for emitting a beam of light comprising multiple
wavelengths towards the sample;
30 a changeable filter (3) positioned between one or more collimation lenses (2b) and a first
dichroic mirror (4a) for allowing a selection of specific wavelength bands to pass through
based on the sample material and thickness, wherein the first dichroic mirror (4a) is positioned

between the changeable filter (3) and a first beam splitter (5a) for transmitting light with a wavelength of less than 700 nm while reflecting light with a wavelength of more than 800 nm;

a second focusing lens (7b) positioned between the first beam splitter (5a) and a visible-light spectrometer (8), wherein the first beam splitter (5a) positioned preferably at an angle to the first dichroic mirror (4a) for directing the light into separate paths for a visible-light spectrometer (8) and a NIR light wavelength-based spectrometer (9), respectively;

a second dichroic mirror (4b) positioned preferably at a right angle to a sample holder (6) and a second beam splitter (5b) for transmitting the light from the collinear first beam splitter (5a) and for reflecting the light from the second beam splitter (5b), wherein the second beam splitter (5b) for dividing the light into a reference path to a third dichroic mirror (4c) and a signal path to the second dichroic mirror (4b) is positioned preferably at a right angle to the first dichroic mirror (4a) and the second dichroic mirror (4b);

a third beam splitter (5c) is positioned preferably at a right angle between the third dichroic mirror (4c) and the sample holder (6) for reflecting light signal from the sample holder (6) and for transmitting the light of the reference path from the third dichroic mirror (4c), wherein a first focusing lens (7a) for controlling the width of the spectrometer is positioned between the third beam splitter (5c) and the NIR light wavelength-based spectrometer (9); and

a processor connected to the visible-light spectrometer (8) and the NIR light wavelength-based spectrometer (9) for analyzing the reflected light and determining the reflectance of the sample,

characterized in that the system further comprises a single broadband light source (1), a visible-light spectrometer (8), and a NIR light wavelength-based spectrometer (9), wherein the visible-light spectrometer (8) captures the light signal with visible wavelength and the NIR light wavelength-based spectrometer (9) captures the light signal with NIR wavelength from the light source (1) with a wide range of wavelength.

13. The system for measuring a thickness of a sample according to claim 12, wherein the light source comprises multiple light-emitting diodes (LEDs) emitting light at a wide range of wavelengths.

14. The system for measuring a thickness of a sample according to claim 12, wherein the visible-light spectrometer (8) detect the intensity and wavelength characteristics of

reflected light after passing through the first focusing lens (7b) from the first beam splitter (5c).

15. The system for measuring a thickness of a sample according to claim 12, wherein
5 the NIR light wavelength-based spectrometer (9) separate the combined reference and signal beams from the third beam splitter (5c).

16. The system for measuring a thickness of a sample according to claim 12, wherein
the changeable filters (3) are interchangeable depending on the materials and thickness of the
10 samples under investigation.

17. The system for measuring a thickness of a sample according to claim 12, wherein
the sample holder further comprises a translation stage in X, Y, and Z directions for holding
the sample for precise scanning of the sample and enabling measurements at different
15 positions.