

CLAIMS

What is claimed is:

1. An apparatus, comprising:

a first photon emitting means configured to emit photons onto a surface of an article at a ~~plurality of~~first azimuthal angles, wherein the first photon emitting means is positioned at a first distance from the surface of the article, wherein the first photon emitting means comprises a high-speed flash lamp configured to reduce vibration;

a second photon emitting means configured to emit photons onto the surface of the article, wherein the first photon emitting means comprises a high-speed flash lamp configured to reduce vibration at a second azimuthal angle, wherein the second photon emitting means is positioned at a second distance from the surface of the article;

a first photon detector array configured to receive photons scattered from a first surface features of the article at a third azimuthal angle, wherein the first photon detector array is associated with the first photon emitting means and synchronized therewith;

a second photon detector array configured to receive photons scattered from a second surface feature of the article at a fourth azimuthal angle, wherein a type of the first surface feature type is different from the second surface feature, and wherein the second photon detector array is associated with the second photon emitting means and synchronized therewith; and

a processing means configured to process photon-detector-array signals corresponding to the photons scattered from the first and the second surface features of the article and morphologically characterize the first and the second surface features of the article, and wherein the processing means is further configured to distinguish between a particle, stain, scratch, and void surface features by processing the photon-detector-array signals, and wherein the processing means is further configured to identify types associated with the first and second surface features based on a wavelength, polarization, coherency, and phase associated with the received photons scattered from the first and second surface features of the article.

2. The apparatus of Claim 1, further comprising a telecentric lens coupled to the first photon detector array.
3. The apparatus of Claim 1, wherein the processing means is further configured to generate at least one surface features map for the article from the photon-detector-array signals corresponding to the photons scattered from the first and the second surface features of the article.
4. The apparatus of Claim 1, wherein the ~~processing means is further configured to generate a plurality of surface features maps for the article from the photon-detector-array signals corresponding to the photons scattered from the surface features of the article, wherein the plurality of surface features maps respectively correspond to the plurality of azimuthal angles~~ second photon emitting means is a light emitting diode (LED) based ring light.
5. The apparatus of Claim 1, further comprising:
a component selected from a group consisting of a wavelength filter, a bandpass filter, a polarization filter, a coherence filter, a periodic array tuned filter, and a phase filter, wherein the component is coupled to the processing means, and wherein the component and the processing means are configured to identify a type associated with a third surface feature of the article, and wherein the type associated with the third surface feature is different from the type associated with the first and the second surface. ~~wherein the processing means comprises one or more computers or equivalent devices configured to process the photon-detector-array signals corresponding to the photons scattered from the surface features of the article.~~
6. The apparatus of Claim 1, ~~wherein the photon-emitting means comprises at least one photon emitter and~~ further comprising a stage configured to support the article.

7. The apparatus of Claim 6, wherein the stage is further configured for rotating and azimuthally positioning the article with respect to the ~~at least one~~ first photon emitter means, and wherein azimuthally positioning the article with respect to the ~~at least one~~ first photon emitter means allows for emitting photons onto the surface of the article at ~~the a~~ plurality of azimuthal angles.

8. The apparatus of Claim 6, wherein ~~a plurality of~~ the first and the second photon emitters are respectively positioned around the stage, ~~at the plurality of azimuthal angles for emitting photons onto the surface of the article at the plurality of azimuthal angles.~~

9. An apparatus, comprising:

a first photon emitting means configured to emit photons onto a surface of an article at a ~~plurality of~~ first azimuthal angles, wherein the first photon emitting means is positioned at a first distance from the surface of the article wherein the first photon emitting means comprises a high-speed flash lamp configured to reduce vibration;

a second photon emitting means configured to emit photons onto the surface of the article, wherein the first photon emitting means comprises a high-speed flash lamp configured to reduce vibration at a second azimuthal angle, wherein the second photon emitting means is positioned at a second distance from the surface of the article; and

a processing means configured to process a signal ~~photon-detector-array signals corresponding to~~ formed in response to detection of photons scattered from a first and a second surface features of the article and further to identify a type associated therewith wherein the processing means is further configured to generate one or more surface features maps for the article from the signal, and wherein the processing means is further configured to determine a respective size of the first and the second surface features based on a detected photon scattering intensity ~~photon-detector-array signals corresponding to the photons scattered from the surface features of the article.~~

10. The apparatus of Claim 9, ~~further comprising a telecentric lens coupled to a photon detector array,~~ wherein the first photon emitting means is coupled to a component selected from a group consisting of a bandpass filter, a polarization filter, a

coherence filter, a periodic array tuned filter, and a phase filter, to identify a type associated with the first surface feature.

~~11. The apparatus of Claim 9, wherein the one or more surface features maps comprises a plurality of surface features maps respectively corresponding to the plurality of azimuthal angles.~~

~~12~~11. The apparatus of Claim 9, wherein the one or more surface features maps comprises a composite surface features map of a plurality of surface features maps respectively corresponding to ~~the plurality of azimuthal angles.~~a plurality of azimuthal angles associated with the first photon emitting means.

~~13~~12. The apparatus of Claim 9, wherein the second photon emitting means is a light emitting diode (LED) based ring light.~~wherein the processing means comprises one or more computers or equivalent devices configured to process the photon detector array signals corresponding to the photons scattered from the surface features of the article.~~

~~14~~13. The apparatus of Claim 9, wherein the photon emitting means comprises at least one photon emitter and a rotatable stage configured for supporting and azimuthally positioning the article with respect to the ~~at least one photon emitter~~first and the second photon emitter means, and wherein azimuthally positioning the article with respect to the ~~at least one photon emitter~~first and second photon emitter means allows for emitting the photons onto the surface of the article at the plurality of azimuthal angles.

~~15~~14. An apparatus, comprising:

a first photon detector array comprising a first plurality of photon detectors configured to receive photons scattered from a first surface features of an article at a first azimuthal angle, wherein photons emitted onto the first surface feature of the article is generated by a high-speed flash lamp configured to reduce vibration, wherein photons emitted onto the first surface feature of the article is generated by a high-speed flash lamp configured to reduce vibration, wherein the first plurality of photon detectors

is further configured to receive photons scattered from additional surface features of the article at a second azimuthal angle;

a second photon detector array comprising a second plurality of photon detectors configured to receive photons scattered from a second surface feature of the article at a third azimuthal angle, wherein the plurality of photon detectors is further configured to receive photons scattered from another additional surface features of the article at a fourth azimuthal angle, wherein a type of the first surface feature type is different from the second surface feature; and

a processor configured to process ~~photon-detector-array signals corresponding to~~a signal formed in response to detection of the photons scattered from the first and the second surface features of the article and generate a plurality of surface features maps for the article from the ~~photon-detector-array signals~~signal corresponding to the photons scattered from the first and the second surface features of the article, and wherein the processor is further configured to identify types associated with the first and second surface features, and wherein the plurality of surface features maps respectively correspond to a plurality of azimuthal angles at which photons are emitted onto the surface of the article, and wherein the processor is further configured to determine a respective size of the first and second surface features based on a detected photon scattering intensity associated with the first and second surface features respectively.

~~16~~15. The apparatus of Claim ~~15~~14, further comprising a telecentric lens coupled to the first photon detector array.

~~17~~16. The apparatus of Claim ~~15~~14, wherein the processor is further configured to generate a composite surface features map for the article from the plurality of surface features maps for the article.

~~18~~17. The apparatus of Claim ~~15~~14, wherein the ~~processor is of one or more computers or equivalent devices configured to process the photon-detector-array signals corresponding to the photons scattered from the surface features of the article~~first photon detector array is positioned at a first distance from the article and

wherein the second photon detector array is positioned at a second distance from the article.

1918. The apparatus of Claim 1514, further comprising a ~~photon emitting means for emitting photons onto the surface of the article at the plurality of azimuthal angles.~~ component selected from a group consisting of a bandpass filter, a polarization filter, a coherence filter, a periodic array tuned filter, and a phase filter, for identifying a type associated with the first surface feature.

2019. The apparatus of Claim 1918, ~~wherein the photon emitting means comprises at least one photon emitter and a rotatable stage configured for supporting and azimuthally positioning the article with respect to the at least one photon emitter, and wherein azimuthally positioning the article with respect to the at least one photon emitter allows for emitting the photons onto the surface of the article at the plurality of azimuthal angles.~~ wherein the processor is further configured to identify chemical characterization of oxides associated with the first and the second surface features.

20. The apparatus of Claim 1, wherein the processing means is configured to determine a length, a width, a height, and a depth associated with the first surface feature type.

21. The apparatus of Claim 1, wherein the first surface feature type is selected from a group consisting of a particle, a stain, a scratch, and a void.

22. The apparatus of Claim 1, wherein the characterization of the first surface feature type of the article includes chemical characterization of oxides.

23. The apparatus of Claim 1, wherein the first photon detector array is positioned at a third distance from the surface of the article and the second photon detector array is positioned at a fourth distance from the surface of the article.