

CLAIMS

What is claimed is:

1. A method of monitoring overlay in a manufacturing process in which successive layers are deposited one over another to form a stack and in which each layer includes a periodic
5 structure to be aligned with a periodic structure in another layer, the method comprising:
illuminating stacked periodic structures with illumination to form positive and negative
first order diffraction patterns from the periodic structures;
capturing an image of the stacked periodic structures including positive and negative
diffraction patterns; and
10 comparing the positive and negative diffraction patterns to calculate the overlay
between successive layers.
2. The method of claim 1 wherein diffraction patterns comprise interference fringes and said
comparing comprises comparing the interference fringe positions to identify any asymmetry
15 between the positive and negative diffraction patterns.
3. The method of claim 2 wherein the interference fringe positions are determined by
analyzing image intensity as a function of position in the image.
- 20 4. The method of claim 1, wherein said comparing comprises determining a characteristic
frequency for each of the positive and negative diffraction patterns, and comparing the
characteristic frequencies to identify an overlay between successive layers.
5. The method of claim 4 wherein the characteristic frequency is determined using a fast
25 Fourier transform.
6. The method of claim 1 comprising determining an asymmetry factor for asymmetry in the
positive and negative diffraction patterns not caused by overlay, and applying the
asymmetry factor to the overlay calculation.
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7. The method of claim 1 wherein said diffraction gratings are part of a multiple cell metrology
target and said capturing comprises a single capture of a single cell in the metrology target.

8. The method of claim 1 in which the positive and negative diffraction patterns are first order diffraction patterns.
9. The method of claim 1 comprising comparing the calculated overlay with a predetermined
5 threshold and generating an alert if the overlay exceeds the threshold.
10. Apparatus for monitoring overlay errors between stacked periodic structures comprising an illumination source, an image capturing device, and an analysis unit including at least one processor, wherein the processor is configured to analyse an image of stacked periodic
10 structures including positive and negative diffraction patterns, and compare the positive and negative diffraction patterns to calculate the overlay between successive layers.
11. The apparatus of claim 10 wherein the processor is configured to identify asymmetry between the positive and negative first order diffraction patterns.
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12. The apparatus of claim 11 wherein the diffraction patterns comprise interference fringes and the processor is configured to determine interference fringe positions by analyzing image intensity as a function of position in the image.
- 20 13. The apparatus of claim 10, wherein said comparing comprises determining a characteristic frequency for each of the positive and negative diffraction patterns, and comparing the characteristic frequencies to identify an overlay between successive layers.
14. The apparatus of claim 13 wherein the processor is configured to determine the
25 characteristic frequency using a fast Fourier transform.
15. The apparatus of claim 10 wherein the processor is configured to determine an asymmetry factor for asymmetry in the positive and negative diffraction patterns not caused by overlay, and apply the asymmetry factor to the overlay calculation.
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16. The apparatus of claim 10 wherein said diffraction gratings are part of a multiple cell metrology target and said processor is configured to perform said analyzing and comparing based on a single capture of a single cell in the metrology target.

17. A computer readable medium comprising instructions which, when implemented in a processor in a computing system cause the system to:
- 5 receive an image of a stacked periodic structure including positive and negative diffraction patterns comprising interference fringes;
 - compare the interference fringe positions in the positive and negative diffraction patterns;
 - identify any asymmetry between the positive and negative diffraction patterns;
 - calculate an overlay between successive layers from the degree of asymmetry between
 - 10 the positive and negative diffraction patterns.
18. The computer readable medium of claim 17 wherein said instructions cause the system to determine an asymmetry factor for asymmetry in the positive and negative diffraction patterns not caused by overlay, and apply the asymmetry factor to the overlay calculation.
- 15 19. The computer readable medium of claim 17 wherein said instructions cause the system to determine a characteristic frequency for the respective positive and negative diffraction patterns.
- 20 20. The computer readable medium of claim 19 wherein the overlay is determined to be proportional to the ratio of the characteristic frequencies.