

CLAIMS

1. A misregistration metrology method for measurement of misregistration in the manufacture of multilayered semiconductor devices, said multilayered semiconductor devices including a first periodic structure having a first pitch along a first axis, said first periodic structure being formed together with a first layer of said multilayered semiconductor device, a second periodic structure having a second pitch along a second axis, said second axis not being parallel to said first axis, said second periodic structure being formed together with said first layer of said multilayered semiconductor device and a third periodic structure having a third pitch along a third axis, said third axis not being parallel to said first axis and said third axis not being parallel to said second axis, said third periodic structure being formed together with a second layer of said multilayered semiconductor device, said third periodic structure and said first and second periodic structures overlying one another;
- 15 said misregistration metrology method comprising:
generating a single image of said first periodic structure, said second periodic structure and third periodic structure, thereby providing an aggregate signal;
extracting a first component from said aggregate signal, said first component being due to said first periodic structure;
- 20 extracting a second component from said aggregate signal, said second component being due to said second periodic structure;
extracting a third component from said aggregate signal, said third component being due to said third periodic structure; and
analyzing said first component, said second component and said third component, thereby to ascertain misregistration between said first layer and said second layer.
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2. The misregistration metrology method according to claim 1 and wherein said single image is generated using a scanning electron microscope using a field of view having a length and an area.
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3. The misregistration metrology method according to claim 2 and wherein said aggregate signal includes contributions from all of said area.
4. The misregistration metrology method according to any of claims 1 – 3
5 and wherein said extracting of said first component from said aggregate signal comprises considering only a portion of said aggregate signal that lies along said first axis.
5. The misregistration metrology method according to any of claims 1 – 4
10 and wherein said extracting of said second component from said aggregate signal comprises considering only a portion of said aggregate signal that lies along said second axis.
6. The misregistration metrology method according to any of claims 1 – 5
15 and wherein said extracting of said third component from said aggregate signal comprises considering only a portion of said aggregate signal that lies along said third axis.
7. The misregistration metrology method according to any of claims 1 – 6
and also comprising:
generating clean first periodic structure data;
20 generating clean second periodic structure data; and
generating clean third periodic structure data.
8. The misregistration metrology method according to claim 7 and wherein
said clean first periodic structure data is a function of said first component and said first
25 pitch.
9. The misregistration metrology method according to claim 7 and wherein
said clean first periodic structure data is a function of said first component, said first pitch
and harmonics of said first pitch.
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10. The misregistration metrology method according to any of claims 7 – 9 and wherein said clean second periodic structure data is a function of said second component and said second pitch.
- 5 11. The misregistration metrology method according to any of claims 7 – 9 and wherein said clean second periodic structure data is a function of said second component, said second pitch and harmonics of said second pitch.
12. The misregistration metrology method according to any of claims 7 – 11
10 wherein said clean third periodic structure data is a function of said third component and said third pitch.
13. The misregistration metrology method according to any of claims 7 – 11 and wherein said clean third periodic structure data is a function of said third component,
15 said third pitch and harmonics of said third pitch.
14. The misregistration metrology method according to any of claims 7 – 13 and wherein said analyzing said first component, said second component and said third component, thereby to ascertain misregistration between said first layer and said second
20 layer comprises:
 identifying a first reference location whereat at least one of maxima and minima of said clean first periodic structure data and said clean second periodic structure data intersect;
 identifying a second reference location whereat at least one of maxima
25 and minima of said clean third periodic structure data most closely intersects said first reference location; and
 calculating a difference between said first reference location and said second reference location, thereby to ascertain misregistration between said first layer and said second layer.
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15. The misregistration metrology method according to any of claims 1 – 13 and wherein:

said second layer also comprises a fourth periodic structure having a fourth pitch along a fourth axis, said fourth axis not being parallel to said first axis, said second axis or said third axis;

5 a fourth component, being due to said fourth periodic structure, is extracted from said aggregate signal;

clean fourth periodic structure data is generated from said fourth component; and

said ascertaining of misregistration between said first layer and said second layer comprises:

10 identifying a first reference location whereat at least one of maxima and minima of said clean first periodic structure data and said clean second periodic structure data intersect;

identifying a second reference location, which most closely intersects said first reference location, whereat at least one of maxima and minima of said
15 clean third periodic structure data and said clean fourth periodic structure data intersect; and

calculating a difference between said first reference location and said second reference location, thereby to ascertain misregistration between said first layer and said second layer.

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16. The misregistration metrology method according to any of claims 2 – 15 and wherein said first pitch, said second pitch and said third pitch are each between $1/1000$ – $1/4$ of said length of said field of view of said wafer imaging tool.

25 17. The misregistration metrology method according to any of claims 2 – 15 and wherein said first pitch, said second pitch and said third pitch are each between $1/500$ – $1/20$ of said length of said field of view of said wafer imaging tool.

18. The misregistration metrology method according to any of claims 1 – 17
30 and wherein said multilayered semiconductor device also comprises at least a third layer formed together with at least a third-layer periodic structure having a third-layer pitch along a third-layer axis, said third-layer axis not being parallel to said first axis, said third-

layer axis not being parallel to said second axis and said third-layer axis not being parallel to said third axis and wherein said method comprises:

generating a single image of said third-layer periodic structure and said first and second periodic structures, thereby providing an aggregate signal;

5 extracting a third-layer component from said aggregate signal, said third-layer component being due to said third-layer periodic structure; and

analyzing said third-layer component, said first component and said second component, thereby to ascertain misregistration between said third layer and said first layer.

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19. A misregistration metrology system for measurement of misregistration in the manufacture of multilayered semiconductor devices, said multilayered semiconductor devices including a first periodic structure having a first pitch along a first axis, said first periodic structure being formed together with a first layer of said multilayered semiconductor device, a second periodic structure having a second pitch along a second axis, said second axis not being parallel to said first axis, said second periodic structure being formed together with said first layer of said multilayered semiconductor device and a third periodic structure having a third pitch along a third axis, said third axis not being parallel to said first axis and said third axis not being parallel to said second axis, said third periodic structure being formed together with a second layer of said multilayered semiconductor device, said third periodic structure and said first and second periodic structures overlying one another;

said misregistration metrology system comprising:

a wafer imaging tool operative to generate a single image of said first periodic structure, said second periodic structure and said third periodic structure, thereby providing an aggregate signal; and

a misregistration analyzer operative to:

extract a first component from said aggregate signal, said first component being due to said first periodic structure;

30 extract a second component from said aggregate signal, said second component being due to said second periodic structure;

extract a third component from said aggregate signal, said third component being due to said at third periodic structure; and

analyze said first component, said second component and said third component, thereby to ascertain misregistration between said first layer and said second layer.

20. The misregistration metrology system according to claim 19 and wherein said wafer imaging tool comprises a scanning electron microscope using a field of view having a length and an area.

21. The misregistration metrology system according to claim 20 and wherein said aggregate signal includes contributions from all of said area.

22. The misregistration metrology system according to any of claims 19 – 21 and wherein said extracting of said first component from said aggregate signal comprises considering only a portion of said aggregate signal that lies along said first axis.

23. The misregistration metrology system according to any of claims 19 – 22 and wherein said extracting of said second component from said aggregate signal comprises considering only a portion of said aggregate signal that lies along said second axis.

24. The misregistration metrology system according to any of claims 19 – 23 and wherein said extracting of said third component from said aggregate signal comprises considering only a portion of said aggregate signal that lies along said third axis.

25. The misregistration metrology system according to any of claims 19 – 24 and wherein said misregistration analyzer is further operative to:

generate clean first periodic structure data;

generate clean second periodic structure data; and

generate clean third periodic structure data.

26. The misregistration metrology system according to claim 25 and wherein said clean first periodic structure data is a function of said first component and said first pitch.
- 5 27. The misregistration metrology system according to claim 25 and wherein said clean first periodic structure data is a function of said first component, said first pitch and harmonics of said first pitch.
28. The misregistration metrology system according to any of claims 25 – 27
10 and wherein said clean second periodic structure data is a function of said second component and said second pitch.
29. The misregistration metrology system according to any of claims 25 – 27
15 and wherein said clean second periodic structure data is a function of said second component, said second pitch and harmonics of said second pitch.
30. The misregistration metrology system according to any of claims 25 – 29
wherein said clean third periodic structure data is a function of said third component and said third pitch.
- 20 31. The misregistration metrology system according to any of claims 25 – 29
and wherein said clean third periodic structure data is a function of said third component, said third pitch and harmonics of said third pitch.
- 25 32. The misregistration metrology system according to any of claims 25 – 31
and wherein said analyzing said first component, said second component and said third component, thereby to ascertain misregistration between said first layer and said second layer comprises:
identifying a first reference location whereat at least one of maxima and
30 minima of said clean first periodic structure data and said clean second periodic structure data intersect;

identifying a second reference location whereat at least one of maxima and minima of said clean third periodic structure data most closely intersects said first reference location; and

calculating a difference between said first reference location and said
5 second reference location, thereby to ascertain misregistration between said first layer and said second layer.

33. The misregistration metrology system according to any of claims 19 – 31 and wherein:

10 said second layer also comprises a fourth periodic structure having a fourth pitch along a fourth axis, said fourth axis not being parallel to said first axis, said second axis or said third axis;

a fourth component, being due to said fourth periodic structure, is extracted from said aggregate signal;

15 clean fourth periodic structure data is generated from said fourth component; and

said ascertaining of misregistration between said first layer and said second layer comprises:

20 identifying a first reference location whereat at least one of maxima and minima of said clean first periodic structure data and said clean second periodic structure data intersect;

identifying a second reference location, which most closely intersects said first reference location, whereat at least one of maxima and minima of said clean third periodic structure data and said clean fourth periodic structure data intersect;

25 and

calculating a difference between said first reference location and said second reference location, thereby to ascertain misregistration between said first layer and said second layer.

30 34. The misregistration metrology system according to any of claims 20 – 33 and wherein said first pitch, said second pitch and said third pitch are each between $1/1000$ – $1/4$ of said length of said field of view of said wafer imaging tool.

35. The misregistration metrology system according to any of claims 20 – 33 and wherein said first pitch, said second pitch and said third pitch are each between $1/500$ – $1/20$ of said length of said field of view of said wafer imaging tool.

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36. The misregistration metrology system according to any of claims 19 – 35 and wherein said multilayered semiconductor device also comprises at least a third layer formed together with at least a third-layer periodic structure having a third-layer pitch along a third-layer axis, said third-layer axis not being parallel to said first axis, said third-layer axis not being parallel to said second axis and said third-layer axis not being parallel to said third axis and wherein said wafer imaging tool is further operative to:

generate a single image of said third-layer periodic structure and said first and second periodic structures, thereby providing an aggregate signal; and wherein said misregistration analyzer is further operative to:

15 extract a third-layer component from said aggregate signal, said third-layer component being due to said third-layer periodic structure; and

analyze said third-layer component, said first component and said second component, thereby to ascertain misregistration between said third layer and said first layer.