CLAIMS:

1. A method for processing semiconductor wafers, the method comprising:

providing a first semiconductor wafer processed by a front-end process tool;

obtaining measurement data from scan lines along a surface of the first semiconductor wafer, the measurement data of each scan line including a thickness profile and a surface profile;

determining a center plane of the wafer based on the measurement data of the scan lines;

generating, for each scan line, a raw shape profile based on the measurement data of the scan line and the center plane of the wafer;

generating, for each scan line, an ideal shape profile based on polynomial regression of the raw shape profile;

generating, for each scan line, a Gapi profile by:

generating, for each scan line, a delta shape profile by comparing the raw shape profile and the ideal shape profile of the scan line;

generating, for each scan line, a weighting profile based on variations in the delta shape profile along a direction of the scan line; and

generating, for each scan line, the Gapi profile based on the delta shape profile and the weighting profile;

calculating a Gapi value of the first semiconductor wafer as a root-mean-square value the Gapi profiles of the scan lines;

determining whether the Gapi value of the first semiconductor wafer is within a predetermined threshold;

if the Gapi value of the first semiconductor wafer is not within the predetermined threshold:

tuning the front-end process tool based on at least one of the Gapi profiles of the scan lines of the first semiconductor wafer; and

processing a second semiconductor wafer with the tuned front-end process tool; and

if the Gapi value of the first semiconductor wafer is within the predetermined threshold, sorting the first semiconductor wafer for polishing.

2. The method of claim 1, wherein the determining the center plane of the wafer is based on regression analysis of the measurement data of the scan lines.

3. The method of claim 2, wherein the regression analysis includes least squares fitting.

4. The method of claim 1, wherein the raw shape profile of each scan line is smoothed by moving average before generating the ideal shape profile of each scan line.

5. The method of claim 1, wherein the generating the ideal shape profile of each scan line is based on second-order polynomial regression of the raw shape profile.

6. The method of claim 1, wherein the weighting profile is generated based on at least one of a shape variation and a slope change of the delta shape profile, each of the shape variation and the slope change being

determined within defined moving windows along the direction of the scan line.

7. The method of claim 1, wherein the front-end process tool is selected from the group consisting of a wire saw, a lapping tool, and a grinding tool.

8. The method of claim 1, wherein the predetermined threshold for the Gapi value is less than or equal to 6.

9. The method of claim 1, wherein the second semiconductor wafer is the same wafer as the first semiconductor wafer.

10. A system for processing semiconductor wafers, the system comprising:

a front-end process tool for front-end processing of a semiconductor wafer;

a flatness inspection tool for obtaining measurement data from scan lines along a surface of the front-end processed wafer, the measurement data of each scan line including a thickness profile and a surface profile; and

a computing device connected to the flatness inspection tool and the front-end process tool, the computing device configured to:

receive the measurement data of the scan lines from the flatness inspection tool;

determine a center plane of the wafer based on the measurement data of the scan lines;

generate, for each scan line, a raw shape profile based on the measurement data of the scan line and the center plane of the wafer;

generate, for each scan line, an ideal shape profile based on polynomial regression of the raw shape profile;

generate, for each scan line, a Gapi profile by:

generating, for each scan line, a delta shape profile by comparing the raw shape profile and the ideal shape profile;

generating, for each scan line, a weighting profile based on variations in the delta shape profile along a direction of the scan line; and

generating, for each scan line, the Gapi profile based on the delta shape profile and the weighting profile;

calculate a Gapi value of the front-end processed wafer as a root-mean-square value the Gapi profiles of the scan lines;

determine whether the Gapi value of the front-end processed wafer is within a predetermined threshold; and

if the Gapi value of the front-end processed wafer is not within the predetermined threshold, modify the front-end process tool based on at least one of the Gapi profiles of the scan lines.

11. The system of claim 10, wherein the computing device is configured to determine the center plane of the wafer based on regression analysis of the measurement data of the scan lines.

12. The system of claim 11, wherein the regression analysis includes least squares fitting.

13. The system of claim 12, wherein the computing device is configured to smooth by moving average the raw shape profile of each scan line before generating the ideal shape profile of each scan line.

14. The system of claim 10, wherein the computing device is configured to generate the ideal shape profile of each scan line based on second-order polynomial regression of the raw shape profile.

15. The system of claim 10, wherein the front-end process tool is selected from the group consisting of a wire saw, a lapping tool, and a grinding tool.

16. The system of claim 10, wherein the predetermined threshold for the Gapi value is less than or equal to 6.

17. A method for processing semiconductor wafers, the method comprising:

providing a first semiconductor wafer processed by a front-end process tool;

obtaining measurement data of an edge profile of the first semiconductor wafer;

determining an edge profile center point based on the measurement data;

generating a raw height profile based on the measurement data and the edge profile center point;

generating an ideal edge profile based on polynomial regression of the raw height profile;

generating a Gapi edge profile of the first semiconductor wafer by:

generating a delta edge profile by comparing the raw height profile and the ideal edge profile;

generating a weighting profile based on variations in the delta edge profile along a direction of the edge profile; and

generating the Gapi edge profile based on the delta edge profile and the weighting profile;

calculating a Gapi edge value of the first semiconductor wafer as a root-mean-square value or as a maximum value of the Gapi edge profile;

determining whether the Gapi edge value of the first semiconductor wafer is within a predetermined threshold;

if the Gapi edge value of the first semiconductor wafer is not within the predetermined threshold:

tuning the front-end process tool based on the Gapi edge profile of the first semiconductor wafer; and

processing a second semiconductor wafer with the tuned front-end process tool; and

if the Gapi edge value of the first semiconductor wafer is within the predetermined threshold, sorting the first semiconductor wafer for polishing.

18. The method of claim 17, wherein the determining the edge profile center point includes applying a simplification algorithm to convert the edge profile measurement data into a simplified curve that includes three points, wherein the edge profile center point is a middle point of the three points.

19. The method of claim 18, wherein the simplification algorithm is an iterative end-point fit algorithm.

20. The method of claim 17, wherein the generating the raw height profile includes extracting an equal number of raw height points on either side of the edge profile center point.

21. The method of claim 17, wherein the generating the ideal edge profile is based on third-order polynomial fitting of the raw height profile.

22. The method of claim 17, wherein the weighting profile is generated based on at least one of a shape variation and a slope change of the delta edge profile, each of the shape variation and the slope change being determined within defined moving windows along the direction of the edge profile.

23. The method of claim 17, wherein the front-end process tool is selected from the group consisting of a wire saw, a lapping tool, and a grinding tool.

24. The method of claim 17, wherein the predetermined threshold for the Gapi edge value is less than or equal to 10.

25. The method of claim 17, wherein the predetermined threshold for the Gapi edge maximum value is less than or equal to 90.

26. The method of claim 17, wherein the second semiconductor wafer is the same wafer as the first semiconductor wafer.

27. A system for processing semiconductor wafers, the system comprising:

a front-end process tool for front-end processing of a semiconductor wafer;

a flatness inspection tool for obtaining measurement data of an edge profile of the front-end processed wafer; and

a computing device connected to the flatness inspection tool and the front-end process tool, the computing device configured to:

receive the measurement data from the flatness inspection tool;

determine an edge profile center point based on the measurement data;

generate a raw height profile based on the measurement data and the edge profile center point;

generate an ideal edge profile based on polynomial regression of the raw height profile;

generate a Gapi edge profile of the front-end processed wafer by:

generating a delta edge profile by comparing the raw height profile and the ideal edge profile;

generating a weighting profile based on at least one of a shape variation and a slope change of the delta edge profile along a direction of the edge profile, each of the shape variation and the slope change being determined within defined moving windows along the direction of the edge profile; and

generating the Gapi edge profile based on the delta edge profile and the weighting profile;

calculate a Gapi edge value of the front-end processed wafer as a root-mean-square value or as a maximum value of the Gapi edge profile;

determine whether the Gapi edge value of the front-end processed wafer is within a predetermined threshold; and

if the Gapi edge value of the front-end processed wafer is not within the predetermined threshold, modify the front-end process tool based on the Gapi edge profile of the front-end processed wafer.

28. The system of claim 27, wherein the computing device is configured to determine the edge profile center point by applying an iterative end-point fit algorithm to convert the edge profile measurement data into a simplified curve that includes three points, wherein the edge profile center point is a middle point of the three points.

29. The system of claim 27, wherein the computing device is configured to generate the raw height profile by extracting an equal number of raw height points on either side of the edge profile center point.

30. The system of claim 27, wherein the computing device is configured to generate the ideal edge profile based on third-order polynomial fitting of the raw height profile.

31. The system of claim 27, wherein the predetermined threshold for the Gapi edge value is less than or equal to 10.

32. The system of claim 27, wherein the predetermined threshold for the Gapi edge maximum value is less than or equal to 90.