CLAIMS

1. A system for determining in-plane distortions of a substrate comprising:

a substrate geometry measurement tool configured to measure out-of-plane distortions of the substrate in an unchucked state; and

a controller communicatively coupled to the measurement tool, the controller including one or more processors configured to execute a set of program instructions, the program instructions configured to cause the one or more processors to:

receive one or more measurement results indicative of out-of-plane distortions of the substrate in the unchucked state from the measurement tool;

determine an effective surface film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state with a two-dimensional plate model;

determine in-plane distortions of the substrate in a chucked state based on the effective surface film stress of the substrate in the unchucked state with the two-dimensional plate model; and

provide the at least one of the measured out-of-plane distortions or the determined in-plane distortions to at least one of a process tool or a metrology tool to adjust the at least one of the process tool or the metrology tool based on the at least one of the measured out-of-plane distortions or the determined in-plane distortions.

2. The system of claim 1, wherein the substrate geometry measurement tool comprises:

a dual Fizeau interferometer.

3. The system of claim 1, wherein the determining an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state with a two-dimensional plate model comprises:

applying a fitting function to the measured out-of-plane distortions; and

determining the effective film stress of the substrate in the unchucked state based on the fitted function with the two-dimensional plate model.

4. The system of claim 3, wherein the fitting function comprises:

a Zernike polynomial.

5. The system of claim 1, wherein the determining an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state with a two-dimensional plate model comprises:

applying a finite difference approximation to determine the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

6. The system of claim 1, wherein the determining an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state with a two-dimensional plate model comprises:

applying a finite element approximation to determine the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

7. The system of claim 1, wherein the determining an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state with a two-dimensional plate model comprises:

applying a finite volume approximation to determine the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

8. The system of claim 1, wherein the determining in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model comprises:

applying a finite difference approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

9. The system of claim 1, wherein the determining in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model comprises:

applying a finite element approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

10. The system of claim 1, wherein the determining in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model comprises:

applying a finite volume approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

11. The system of claim 1, wherein the determining in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model comprises:

applying a method of moments approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

12. The system of claim 1, wherein the metrology tool comprises:
an overlay metrology tool.

13. The system of claim 1, wherein the substrate comprises:
a semiconductor wafer.

14. A system for determining in-plane distortions of a substrate comprising:
a substrate geometry measurement tool configured to measure out-of-plane distortions of the substrate in an unchucked state; and
a controller communicatively coupled to the measurement tool, the controller including one or more processors configured to execute a set of program instructions, the program instructions configured to cause the one or more processors to:
receive one or more measurement results indicative of out-of-plane distortions of the substrate in the unchucked state from the measurement tool;
apply a two-dimensional plate model to determine in-plane distortions of the substrate in a chucked state based on the out-of-plane distortions of the substrate in the unchucked state; and
provide the at least one of the measured out-of-plane distortions or the determined in-plane distortions to at least one of a process tool or an overlay tool to adjust the at least one of the process tool or the overlay tool based on the at least one of the measured out-of-plane distortions or the determined in-plane distortions.

15. A system for determining in-plane distortions of a substrate comprising:
a substrate geometry measurement tool configured to measure out-of-plane distortions of the substrate in an unchucked state; and
a controller communicatively coupled to the measurement tool, the controller including one or more processors configured to execute a set of program instructions, the program instructions configured to cause the one or more processors to:
receive one or more measurement results indicative of out-of-plane distortions of the substrate in the unchucked state from the measurement tool;
apply an Euler-Lagrange plate model to determine in-plane distortions of the substrate in a chucked state based on the out-of-plane distortions of the substrate in the unchucked state; and
provide the at least one of the measured out-of-plane distortions or the determined in-plane distortions to at least one of a process tool or an overlay tool to adjust the at least one of the process tool or the overlay tool based on the at least one of the measured out-of-plane distortions or the determined in-plane distortions.

16. A method for determining in-plane distortions of a substrate comprising:

measuring one or more out-of-plane distortions of the substrate in an unchucked state;

determining, with a two-dimensional plate model, an effective film stress of a film on the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state;

determining, with the two-dimensional plate model, in-plane distortions of the substrate in a chucked state based on the effective film stress of the film on the substrate in the unchucked state; and

providing the at least one of the measured out-of-plane distortions or the determined in-plane distortions to at least one of a process tool or an overlay tool to adjust the at least one of the process tool or the overlay tool based on the at least one of the measured out-of-plane distortions or the determined in-plane distortions.

17. The method of claim 16, wherein the determining, with a two-dimensional plate model, an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state comprises:

applying a fitting function to determine the effective film stress of the substrate in the unchucked state; and

determining the effective film stress of the substrate in the unchucked state based on the fitted function with the two-dimensional plate model.

18. The method of claim 16, wherein the determining, with a two-dimensional plate model, an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state comprises:

applying a finite difference approximation to determine the effective film stress of the substrate in the unchucked state.

19. The method of claim 16, wherein the determining, with a two-dimensional plate model, an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state comprises:

applying a finite element approximation to determine the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

20. The method of claim 16, wherein the determining, with a two-dimensional plate model, an effective film stress of the substrate in the unchucked state based on the measured out-of-plane distortions of the substrate in the unchucked state comprises:

applying a finite volume approximation to determine the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

21. The method of claim 16, wherein the determining, with the two-dimensional plate model, in-

plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state comprises:

applying a finite difference approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

22. The method of claim 16, wherein the determining, with the two-dimensional plate model, in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state comprises:

applying a finite element approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

23. The method of claim 16, wherein the determining, with the two-dimensional plate model, in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state comprises:

applying a finite volume approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.

24. The method of claim 16, wherein the determining, with the two-dimensional plate model, in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state comprises:

applying a method of moments approximation to determine the in-plane distortions of the substrate in a chucked state based on the effective film stress of the substrate in the unchucked state with the two-dimensional plate model.