CLAIMS

1. A method for cleaning, comprising:

providing a wafer having a surface, the surface having a particle thereon;

providing a cleaning media on the surface, the cleaning media including one or more dispersed coupling elements suspended therein; and

applying external energy to the cleaning media, the application of the external energy to the cleaning media generating a periodic shear stress within the cleaning media,

wherein the periodic shear stress imparts a force on at least one of the one or more of the coupling elements, the force causing an interaction between the at least one of the one or more coupling elements and the particle to remove the particle from the surface, and

wherein the external energy is high frequency megasonic acoustic energy having a frequency of approximately 600 KHz to approximately 3 MHz.

2. The cleaning method as recited in claim 1, wherein applying the external energy to the cleaning media includes applying the external energy using one or more of megasonics, sonication, piezo electric actuation, piezo acoustic actuation, cavitation, and evaporation.

3. The cleaning method as recited in claim 2, wherein the external energy is applied to the cleaning media via the wafer, wherein the wafer transfers the external energy to the cleaning media.

4. The cleaning method as recited in claim 2, wherein the external energy is applied directly to the cleaning media from a confined source.

~~5. The cleaning method as recited in claim 1, wherein the external energy is high frequency megasonic acoustic energy having a frequency of approximately 600 KHz to approximately 3 MHz.~~

~~6. The cleaning method as recited in claim 1, wherein the external energy is ultrasonic energy having a frequency of approximately 50 Hz to approximately 100 KHz.~~

57. The cleaning method as recited in claim 1, wherein the interaction is defined by one or more of mechanical coupling, chemical coupling, or electrostatic coupling between the at least one of the one or more coupling elements and the particle.

68. The cleaning method as recited in claim 57, wherein the mechanical coupling is defined by adhesion between the at least one of the one or more coupling elements and the particle, such that the particle is lifted away from the surface along with the at least one of the one or more coupling elements.

79. The cleaning method as recited in claim 57, wherein the mechanical coupling is defined by a physical collision between the at least one of the one or more coupling elements and the particle, such that a transfer of energy from the at least one of the one or more coupling elements to the particle causes the particle to lift away from the surface.

810. The cleaning method as recited in claim 57, wherein the chemical coupling is defined by physical contact and chemical compatibility between the at least one of the one or more coupling elements and the particle, the physical contact facilitating chemical adhesion between the at least one of the one or more coupling elements and the particle.

911. The cleaning method as recited in claim 57, wherein the electrostatic coupling is defined by an attractive or repulsive interaction between the at least one of the one or more coupling elements and the particle.

102. The cleaning method as recited in claim 1, wherein the force is defined by drag or momentum or a combination thereof.

113. The cleaning method as recited in claim 1, wherein the cleaning media includes one of:

a liquid component, a gas component, and a solid component; or

a liquid component and a solid component.

124. The cleaning method as recited in claim 113, wherein the solid component corresponds to the one or more dispersed coupling elements.

135. The cleaning method as recited in claim 124, wherein the solid component is one of a material of aliphatic acids, carboxylic acids, paraffin, wax, polymers, polystyrene, polypeptides, fatty acids, and visco-elastics.

146. The cleaning method as recited in claim 113, wherein the gas component is one of a gas mixture of:

ozone (O_3), oxygen (O_2), hydrochloric acid (HCl), hydrofluoric acid (HF), nitrogen (N_2), and argon (Ar);

ozone (O_3) and nitrogen (N_2);

ozone (O_3) and argon (Ar);

ozone (O_3), oxygen (O_2) and nitrogen (N_2);

ozone (O_3), oxygen (O_2) and argon (Ar);

ozone (O_3), oxygen (O_2), nitrogen (N_2), and argon (Ar); and

oxygen (O_2), argon (Ar) and nitrogen (N_2).

157. The cleaning method as recited in claim 113, wherein the liquid component is aqueous or non-aqueous.

168. A system for cleaning, comprising:

a carrier for supporting a wafer having a surface, the surface having a particle thereon;

a tank having a cavity defined by a base and one or more sidewalls extending therefrom, the tank being configured to hold a volume of a cleaning media within the cavity to immerse the wafer, wherein the cleaning media includes one or more dispersed coupling elements suspended therein; and

one or more transducers coupled to at least one of the one or more sidewalls or the base, the one or more transducers applying acoustic energy to the cleaning media,

wherein the acoustic energy generates a periodic shear stress within the cleaning media,

wherein the transducer is the megasonic transducer, and wherein a frequency of the acoustic energy is from approximately 600 KHz to approximately 3 MHz, and

wherein the periodic shear stress imparts a force on at least one of the one or more dispersed coupling elements causing the at least one of the one or more dispersed coupling element to interact with the particle to facilitate the removal of the particle from the surface.

~~19. The system as recited in claim 18, wherein the transducer is a megasonic transducer or an ultrasonic transducer.~~

~~20. The system as recited in claim 19, wherein the transducer is the megasonic transducer, and wherein a frequency of the acoustic energy is from approximately 600 KHz to approximately 3 MHz.~~

~~21. The system as recited in claim 19, wherein the transducer is the ultrasonic transducer, and wherein a frequency of the acoustic energy is from approximately 50 Hz to approximately 100 KHz.~~

17~~22~~. A system for cleaning, comprising:

a processing chamber having a carrier element, the carrier element being capable of supporting a wafer within the processing chamber such that a surface of the wafer is exposed, the exposed wafer surface having a particle thereon; and

a jet assembly, wherein the jet assembly is configured to generate acoustic energy, apply the acoustic energy to a cleaning media as the cleaning media travels along a throughway of the jet assembly, wherein the cleaning media includes one or more dispersed coupling elements suspended therein and the acoustic energy alters a physical characteristic of each of the dispersed coupling elements before application of the cleaning media to the exposed wafer surface, and wherein fluid motion from a jet of the jet assembly imparts a force on at least one of the altered one or more dispersed coupling elements causing the at least one of the altered one or more dispersed coupling element to interact with the particle to remove the particle from the exposed wafer surface.

18~~23~~. The system as recited in claim 17~~22~~, wherein each of the altered coupling elements enhance removal of the particle from the exposed wafers surface.

19~~24~~. The system as recited in claim 17~~22~~, wherein a size distribution of each of the altered coupling elements broadens, narrows, or shifts to a smaller mean size.

20~~25~~. The system as recited in claim 17~~22~~, wherein the physical characteristic of each of the coupling elements is one or more of size and shape.

21~~6~~. A system for cleaning, comprising:

a processing chamber having a carrier element, the carrier element being capable

of supporting a wafer within the processing chamber such that a surface of the wafer having a particle disposed thereon is exposed;

a fluid supply assembly, the fluid supply assembly being configured to supply a cleaning media to the surface, the cleaning media including one or more dispersed coupling elements suspended therein; and

a energy source capable of generating a high frequency megasonic acoustic energy having a frequency of approximately 600 KHz to approximately 3 MHz, wherein the acoustic energy is applied to cleaning media at surface, thereby generating a periodic shear stress within the cleaning media, the periodic shear stress imparting a force on at least one of the one or more dispersed coupling elements causing the at least one of the one or more dispersed coupling element to interact with the particle to remove the particle from the surface.

22~~7~~. A system for cleaning, comprising:

a transducer capable of generating acoustic energy disposed proximal to a back surface of a wafer, the wafer including a front surface opposite the back surface, the front surface having a particle thereon;

a first fluid supply assembly, the first fluid supply assembly being capable of supplying a liquid layer between the back surface of the wafer and the transducer;

a second fluid supply assembly, the second fluid supply assembly being capable of supplying a cleaning media including one or more dispersed coupling elements suspended therein on the front surface of the wafer,

wherein the acoustic energy is transferred from the transducer through the liquid layer and the wafer into the cleaning media at the front surface of the wafer, thereby generating a periodic shear stress within the cleaning media, the periodic shear stress imparting a force on at least one of the one or more dispersed coupling elements causing the at least one of the one or more dispersed coupling element to interact with the particle to remove the particle from the front surface, and

wherein the transducer is the megasonic transducer, and wherein a frequency of the acoustic energy is from approximately 600 KHz to approximately 3 MHz.

~~28. The system as recited in claim 27, wherein the transducer is a megasonic transducer or an ultrasonic transducer.~~

~~29. The system as recited in claim 28, wherein the transducer is the megasonic transducer, and wherein a frequency of the acoustic energy is from approximately 600 KHz to approximately 3 MHz.~~

~~30. The system as recited in claim 28, wherein the transducer is the ultrasonic transducer, and wherein a frequency of the acoustic energy is from approximately 50 Hz to approximately 100 KHz.~~

2331. The system as recited in claim in claim 227, wherein the liquid layer is one of deionized wafer, ammonia hydrogen peroxide mixture (APM), surfactant solution, or non-aqueous liquid.