CLAIMS

1. An apparatus for uniform metallization on substrate comprising:

an immersion bath containing at least one metal salt electrolyte;

at least one set of electrode connecting to an independent power supply;

a substrate holder holding at least one substrate and electrically connecting with a conductive side of the substrate, the conductive side of the substrate exposed to face the electrode;

at least one ultra/mega sonic device and a reflection plate disposed parallel for generating ultra/mega sonic standing wave in the immersion bath; and

a rotating actuator rotating the substrate holder along its axis in the standing wave field, so as to result in a uniform overall power intensity distribution across the substrate in an accumulated time; wherein the apparatus further comprises

a horizontal actuator oscillating the substrate holder along a direction tilted an angle θ relative to normal direction of propagation direction of the ultra/mega sonic standing wave, and wherein the θ is 0-45 degrees.

2. The apparatus of claim 1, further comprising a horizontal actuator oscillating the substrate holder along propagation direction of the ultra/mega sonic standing wave.

3. The apparatus of claim 2, wherein the amplitude of the substrate oscillation equals to $N \bullet \frac{\lambda}{4}$, N=1, 2, 3…where λ is the wavelength of the ultra/mega sonic standing wave and N is an integer.

4. The apparatus of claim 1, wherein the amplitude of the substrate oscillation equals to $\frac{N \bullet \frac{\lambda}{4}}{\sin\theta}$, N=1, 2, 3…where λ is the wavelength of the ultra/mega sonic standing wave and N is an integer, θ is the angle between the substrate oscillation

direction and the normal direction of propagation direction of the ultra/mega sonic standing wave.

5. The apparatus of claim 1, further comprising a vertical actuator moving the substrate holder up and down to load or unload the substrate into or out of the immersion bath.

6. The apparatus of claim 1, further comprising a vertical actuator oscillating the substrate holder along a direction that an angle θ is formed between the substrate holder oscillation direction and normal direction of propagation direction of the ultra/mega sonic standing wave.

7. The apparatus of claim 6, wherein the amplitude of the substrate oscillation equals to $\frac{N \bullet \frac{\lambda}{4}}{\sin\theta}$, N=1, 2, 3…where λ is the wavelength of the ultra/mega sonic standing wave and N is an integer, θ is the angle between the substrate oscillation direction and the normal direction of propagation direction of the ultra/mega sonic standing wave.

8. The apparatus of claim 6, wherein the vertical actuator moves the substrate holder up and down to load or unload the substrate into or out of the immersion bath.

9. The apparatus of claim 6, wherein the vertical actuator oscillates the substrate holder along the direction perpendicular to the horizontal plane.

10. The apparatus of claim 6, wherein the vertical actuator oscillates the substrate holder along the direction tilted an angle relative to the normal direction of the horizontal plane.

11. The apparatus of claim 10, wherein the substrate and the electrode are set with a tilted angle relative to the horizontal plane.

12. The apparatus of claim 1, wherein each set of electrode includes one piece of electrode or more pieces of electrodes with independent power control.

13. The apparatus of claim 1, further comprising at least one layer of permeable membrane being set between the substrate and the electrode.

14. The apparatus of claim 1, wherein the rotation speed of the rotating actuator is in the range of 10 to 100rpm.

15. The apparatus of claim 1, wherein the ultra/mega sonic device and the reflection plate are mounted on opposite sidewalls of the immersion bath and tilt an angle θ relative to the substrate oscillation direction, and the substrate is set parallel to the horizontal plane, the substrate oscillation direction is perpendicular to the horizontal plane.

16. The apparatus of claim 1, wherein the ultra/mega sonic device and the reflection plate are mounted on opposite sidewalls of the immersion bath and perpendicular to the horizontal plane, the substrate and the electrode are set with a tilted angle relative to the horizontal plane, the substrate is oscillated along a direction tilted the angle relative to the normal direction of the horizontal plane.

17. The apparatus of claim 1, further comprising an adjusting mechanism for adjusting the surface of the reflection plate to be parallel to the surface of the ultra/mega sonic device.

18. The apparatus of claim 17, wherein the adjusting mechanism includes an oscillating actuator for oscillating the reflection plate along propagation direction of the ultra/mega sonic standing wave, the oscillation amplitude is equal to N times of half wavelength of the ultra/mega sonic standing wave, N is an integer number from 1 to 10.

19. The apparatus of claim 18, wherein the frequency of the oscillating actuator is 1 to 10 HZ.

20. A method for uniform metallization on substrate comprising:

supplying at least one metal salt electrolyte into an immersion bath;

transferring a substrate to a substrate holder that is electrically connected with a conductive side of the substrate and the conductive side of the substrate exposed to face an electrode connecting to an independent power supply;

applying a first bias voltage to the substrate;

rotating the substrate;

immersing the substrate into the immersion bath;

applying an electrical current to the substrate;

turning on an ultra/mega sonic device;

oscillating the substrate holder in the acoustic wave field, and meanwhile periodically changing the distance of space between the ultra/mega sonic device and a reflection plate;

turning off the ultra/mega sonic device and stopping oscillation of the substrate holder and stopping periodically changing the distance of space between the ultra/mega sonic device and the reflection plate;

applying a second bias voltage to the substrate;

bringing the substrate out of the metal salt electrolyte; and

stopping rotating the substrate.

21. The method of claim 20, wherein

the first bias voltage is 0.1V to 10V;

the electrical current is 0.1A to 100A;

the ultra/mega sonic device has an operating frequency of 20KHz to 10MHz and a power intensity of 0.01 to 3W/cm2;

the substrate oscillates with an amplitude of 1mm to 300mm and a frequency of 0.001 to 0.5Hz;

the second bias voltage is 0.1V to 5V.

22. The method of claim 20, wherein the substrate rotates with a rotation speed in range of 10rpm to 100rpm.

23. The method of claim 20, wherein the amplitude of the substrate oscillation equals to $\frac{N \bullet \frac{\lambda}{4}}{\sin\theta}$, N=1, 2, 3…where λ is the wavelength of the ultra/mega sonic wave and N is an integer, θ is the angle between substrate oscillation direction and the normal direction of propagation direction of the ultra/mega sonic wave.

24. The method of claim 20, wherein the frequency of the space distance changing periodically is larger than the frequency of substrate oscillation.

25. The method of claim 20, wherein the amplitude of the substrate oscillation in the acoustic wave field is controlled as integer times of quarter wavelength of the ultra/mega sonic wave.

26. The method of claim 20, wherein the substrate oscillates with an angle θ in range of 0 to 45 degree, tilted to the normal direction of propagation direction of the

ultra/mega sonic wave, and the amplitude of the substrate oscillation equals to $\frac{N \bullet \frac{\lambda}{4}}{\sin\theta}$, N=1, 2, 3…where λ is the wavelength of the ultra/mega sonic wave and N is an integer.