CLAIMS

1. An electroplating apparatus comprising:

(a) a plating chamber configured to contain an electrolyte and an anode while electroplating metal onto a substrate, the substrate being substantially planar;

(b) a substrate holder configured to support the substrate such that a plating face of the substrate is immersed in the electrolyte and separated from the anode during plating;

(c) an ionically resistive element adapted to provide ionic transport through the ionically resistive element during electroplating, wherein the ionically resistive element comprises a plate that is at least about coextensive with the substrate and a plurality of through-holes formed in the plate;

(d) an ionically resistive element manifold positioned below the ionically resistive element, wherein during electroplating electrolyte passes from the ionically resistive element manifold, through the through-holes in the ionically resistive element;

(e) a cross flow manifold positioned above the ionically resistive element and below the plating face of the substrate, when the substrate is present in the substrate holder;

(f) a side inlet for introducing electrolyte to the cross flow manifold;

(g) a side outlet for receiving electrolyte flowing in the cross flow manifold, wherein the side inlet and side outlet are positioned proximate azimuthally opposing perimeter locations on the plating face of the substrate during electroplating, and wherein the side inlet and side outlet are adapted to generate cross-flowing electrolyte in the cross flow manifold during electroplating; and

(h) a three-way valve that controls delivery of electrolyte to each of (i) the side inlet and (ii) the ionically resistive element manifold.

2. The apparatus of claim 1, further comprising a controller configured to switch the three way valve during electroplating to provide at least a first flow pattern and a second flow pattern while electroplating on the substrate.

3. The apparatus of claim 2, wherein the second flow pattern provides a relatively greater degree of impinging electrolyte at the plating face of the substrate, as compared to the first flow pattern.

4. The apparatus of claim 1, wherein the three way valve permits independent control over delivery of electrolyte to the side inlet and to the ionically resistive element manifold.

5. The apparatus of claim 1, further comprising a controller configured to switch the three way valve during electroplating to provide at least a first plating regime and a second plating regime while electroplating on the substrate, wherein during the first plating regime, a first flow pattern is provided, wherein during the second plating regime, a second flow pattern and a third flow pattern are cyclically provided, and wherein the second flow pattern provides a relatively greater degree of impinging electrolyte on the plating face of the substrate, as compared to the first flow pattern.

6. The apparatus of claim 5, wherein the controller is configured to operate the three way valve such that (i) the first flow pattern delivers electrolyte to both the side inlet and to the ionically resistive element manifold, and (ii) the second flow pattern delivers electrolyte to the ionically resistive element manifold, but not to the side inlet.

7. The apparatus of claim 5, wherein the controller is configured to operate the three way valve such that the first flow pattern and second flow pattern each deliver electrolyte to both the side inlet and to the ionically resistive element manifold, wherein a flow of electrolyte to the side inlet is relatively greater in the first flow pattern compared to the second flow pattern, and wherein a flow of electrolyte to the ionically resistive element manifold is relatively greater in the second flow pattern compared to the first flow pattern.

8. The apparatus of claim 1, wherein the three way valve controls delivery of electrolyte to the side inlet and to the ionically resistive element manifold in a non-independent manner such that when a flow of electrolyte to the side inlet increases, a flow of electrolyte to the ionically resistive element manifold decreases, and vice versa.

9. The apparatus of claim 1, wherein the ionically resistive element comprises a plurality of ribs on an upper surface of the ionically resistive element, the ribs being linear and extending across the cross flow manifold.

10. The apparatus of claim 9, further comprising a plurality of electrolyte jets formed in the ribs on the ionically resistive element.

11. The apparatus of claim 10, wherein electrolyte delivered to the plurality of electrolyte jets is electrically isolated from the anode.

12. The apparatus of claim 11, further comprising a membrane frame for supporting a membrane that separates the anode from the substrate during electroplating, wherein the membrane frame defines a bottom surface of the ionically resistive element manifold, and further comprising an electrolyte conduit formed in the membrane frame and in the ionically resistive element, wherein the electrolyte conduit provides electrolyte to the plurality of electrolyte jets.

13. The apparatus of claim 12, further comprising a second three way valve that controls delivery of electrolyte to the ionically resistive element manifold and to the electrolyte conduit formed in the membrane frame and in the ionically resistive element.