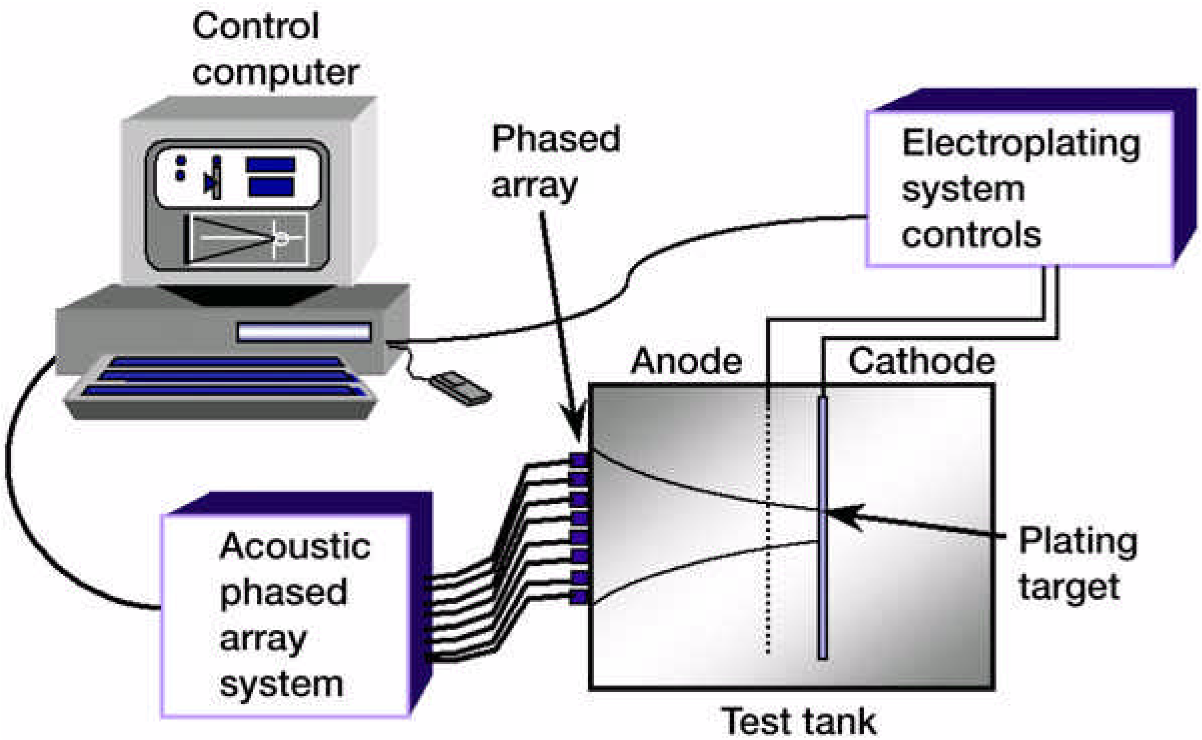
Acoustically Enhanced Electroplating Being Developed

In cooperation with the NASA Glenn Research Center, Alchemitron Corp. is developing the Acoustically Enhanced Electroplating Process (AEEP), a new technique of employing nonlinear ultrasonics to enhance electroplating. The applications range from electroplating full-panel electronic circuit boards to electroplating microelectronics and microelectromechanical systems (MEMS) devices. In a conventional plating process, the surface area to be plated is separated from the nonplated areas by a temporary mask. The mask may take many forms, from a cured liquid coating to a simple tape. Generally, the mask is discarded when the plating is complete, creating a solid waste product that is often an environmental hazard. The labor and materials involved with the layout, fabrication, and tooling of masks is a primary source of recurring and nonrecurring production costs. The objective of this joint effort, therefore, is to reduce or eliminate the need for masks.

AEEP improves selective plating processes by using directed beams of high-intensity acoustic waves to create nonlinear effects that alter the fluid dynamic and thermodynamic behavior of the plating process. It relies on two effects: acoustic streaming and acoustic heating. Acoustic streaming is observed when a high-intensity acoustic beam creates a liquid current within the beam. The liquid current can be directed as the beam is directed and, thus, users can move liquid around as desired without using pumps and nozzles. The current of the electroplating electrolyte, therefore, can be directed at distinct target areas where electroplating is desired. The current delivers fresh electrolyte to the target area while flushing away the spent electrolyte. This dramatically increases the plating rate in the target area. In addition, acoustic heating of both the liquid in the beam and the target surface increases the chemical reaction rate, which further increases the plating rate. The combined effects of acoustic streaming and heating accelerate the deposition of plating in that area and, thus, provide an effect similar to a mask but without the costs of masking. AEEP further improves the plating process by clearing debris and bubbles from the surface by acoustic radiation pressure and acoustic streaming.

As an alternative to the immersion form of plating just described, AEEP can also perform selective plating by using acoustic radiation pressure to create an acoustic fountain from a liquid pool. This approach raises a liquid fountain of plating solution and brings it into contact with the part suspended over a pool. The fountain can be moved around to draw a plating pattern on the part. This approach is expected to be most effective in conveyorized plating lines.

All these acoustic effects use high-frequency, high-intensity acoustic transducers and a means of directing a beam of acoustic waves. The complexity may range from a simple transducer with a fixed acoustic lens to a complex array of many elements in an acoustic phased array. Acoustic phased-array technology promises to provide the flexibility of electronically steered and focused beams. In turn, this flexibility will allow users to "draw" a pattern on the target surface under computer control. In this way, AEEP is expected to make electroplated products, which were formerly tooling and labor intensive, as simple to produce as computer-printed graphics.



Advanced electroplating system incorporating acoustic phased-array technology. The control computer operates the electroplating system controls and the acoustic phased array system drivers. In the test tank holding the liquid, there is the required anode and cathode of the plating target. The phased array transducers are coupled into the liquid so that the acoustical energy is focused on the target, thereby assisting the plating process. Illustration shows the control computer, electroplating system controls, anode, cathode, plating target, test tank, phased array, and acoustic phased-array system.

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