Integrated Electrode Arrays for Neuro-Prosthetic Implants

Integrated array would eliminate the need for extensive cabling in implants.

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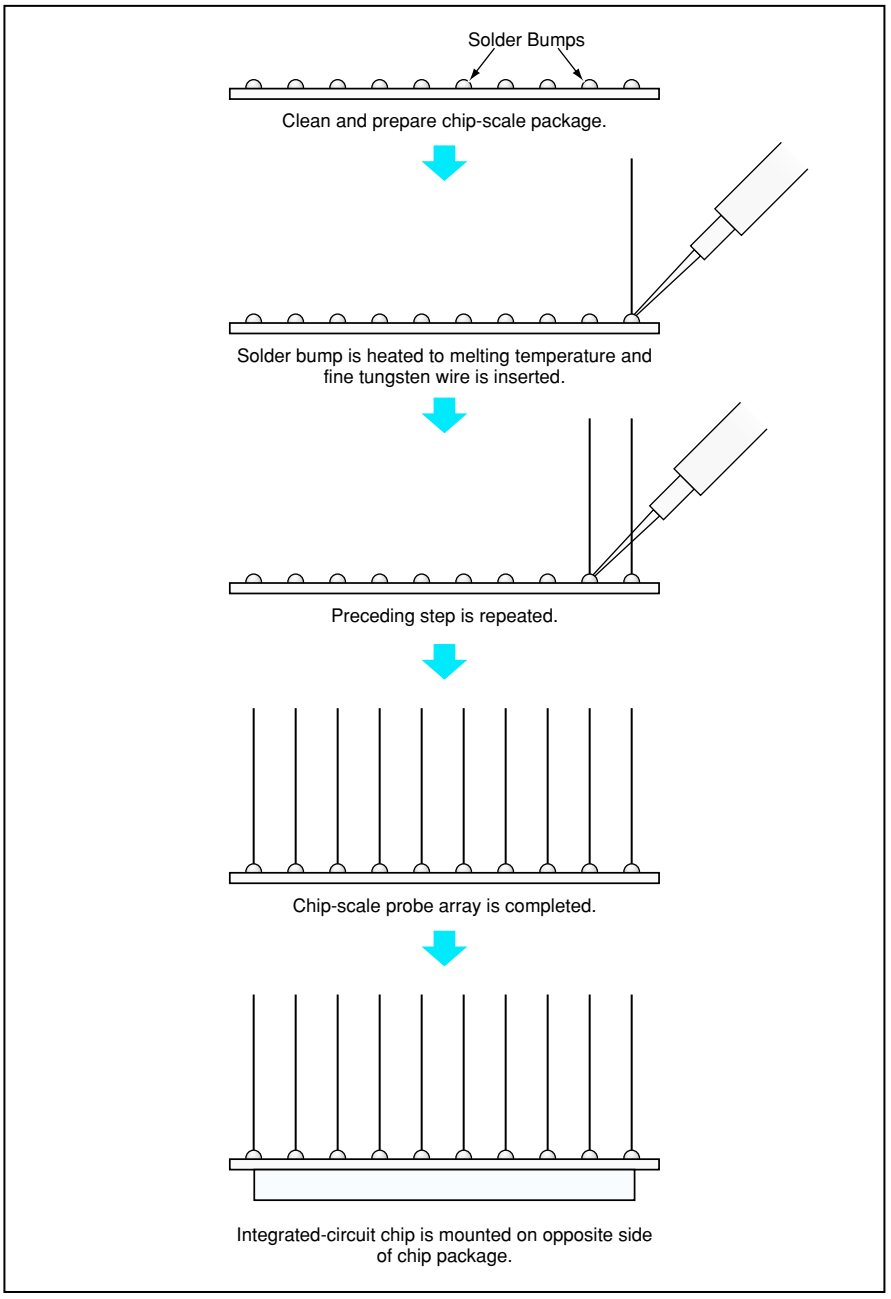
Arrays of electrodes integrated with chip-scale packages and silicon-based integrated circuits have been proposed for use as medical electronic implants, including neuro-prosthetic devices that might be implanted in brains of patients who suffer from strokes, spinal-cord injuries, or amyotrophic lateral sclerosis. The electrodes of such a device would pick up signals from neurons in the cerebral cortex, and the integrated circuit would perform acquisition and preprocessing of signal data. The output of the integrated circuit could be used to generate, for example, commands for a robotic arm.

Electrode arrays capable of acquiring electrical signals from neurons already exist, but heretofore, there has been no convenient means to integrate these arrays with integrated-circuit chips. Such integration is needed in order to eliminate the need for the extensive cabling now used to pass neural signals to data-acquisition and -processing equipment outside the body. The proposed integration would enable progress toward neuro-prostheses that would be less restrictive of patients' mobility.

An array of electrodes would comprise a set of thin wires of suitable length and composition protruding from and supported by a fine-pitch micro-ball grid array or chip-scale package (see figure). The associated integrated circuit would be mounted on the package face opposite the probe face, using the solder bumps (the balls of the ball grid array) to make the electrical connections between the probes and the input terminals of the integrated circuit. The key innovation is the insertion of probe wires of the appropriate length and material into the solder bumps through a reflow process, thereby fixing the probes in place and electrically connecting them with the integrated circuit.

The probes could be tailored to any distribution of lengths and made of any suitable metal that could be drawn into fine wires. Furthermore, the wires could be coated with an insulating layer using anodization or other processes, to achieve the correct electrical impedance. The probe wires and the packaging materials must be biocompatible using such materials as lead-free solders. For protection, the chip and package can be coated with parylene.

This work was done by Erik Brandon and Mohammed Mojarradi of Caltech for



Conceptual Process Flow shows wires supported and electrically connected by solder bumps, which would serve as electrodes for acquiring signals from neurons. The integrated circuit would preprocess the signals for use by external circuits.

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