Chip-Bonding for Integrated Circuit by using Micro-spring Probe

Chinami Kaneshiro, Kohji Hohkawa
Kanagawa Institute of Technology
1030 Shimo-Ogino Atsugi-shi Kanagawa, 243-0292, Japan

In this paper, we present the results of a basic study on the fabrication of a micro-spring contact probe with an Au plating bump. We also discuss the use of sputter-deposition to fabricate the micro-spring contact probes and examine contact resistance in Au electrode pads in relation to using Au plating bumps to reduce contact resistance.

Even though devices are becoming smaller, the area occupied by the pad and wiring is still significant. The problem with interconnect and/or probing technology in ICs is contact resistance between the electrode pads in devices and contact probes.

Figure 1 shows a schematic illustration of our proposed micro-contact probe with an Au bump for interconnect and probing technology. The wire spring is made of elastic metal materials, e.g., Mo-Cr. Spring wire is used for interconnects in three-dimensional wiring as well as for probes in scanning probing microscopy and wafer probing. The advantage of using wire springs in three-dimensional wiring is that they can be connected to different layers of spatial wiring. However, the resistance of Mo-Cr is larger than that of Au or Cu, which are used for wiring in ICs. This problem can be overcome by coating the Mo-Cr spring probe with an Au thin film. However, it is likely that the Au thin film will be stripped off a contact probe. This problem can be solved by forming an Au bump on the tip of the probe and then welding between the electrode pad and the Au bump. Forming an Au bump on the probe tip is an effective way of reducing contact resistance in probing technology.

We used a Si substrate covered with SiO_2 thin film as a base substrate. Micro-fingers were patterned on the substrate using photolithography. After the patterning, the elastic alloy Mo-Cr was sputter-deposited on to the substrate. To prevent mechanical damage, hard, elastic metals, such as Mo-Cr, are used for contact probes with fine patterns. Figure 2 shows a scanning electron micrograph (SEM) of one complete array of fingers. The fingers are 5-µm wide with 50-µm pitches. In Fig. 2(b), the shadow of the rectangular released-etching can be seen framing the lifted area.

The Au bump was fabricated before the SiO_2 was etched. An open window in the resist film was formed for use as a mask during the plating process.

We examined the contact resistance of an Au electrode formed using electron-beam (EB) deposition and electrolysis plating. Table I summarizes the contact resistance of Au metal electrodes formed using various deposition methods. The experimental results indicated that there is lower contact resistance with plating than with EB deposition.

We compared the contact resistance of metal electrode pads formed used various deposition methods. The results indicate that the formation of Au plating bumps on the tip of a metal spring is effective in reducing contact resistance. The reduction in contact resistance may be affected by the size of the metal particles.

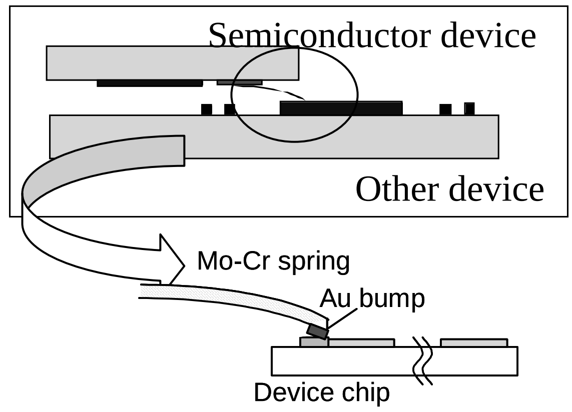

Figure 1 Schematic illustrations of proposed contact probe.

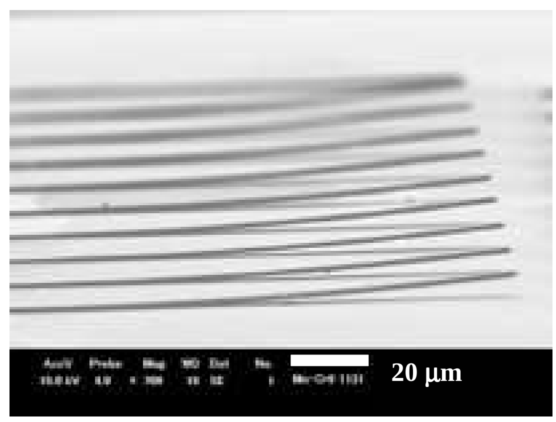

Figure 2 Scanning electron micrograph of cross-section of lift-up finger array.

Table I Contact resistance and sheet resistance of metals deposited using various process.

Material	Contact resistance (Ω)	Sheet resistance ($m\Omega$/□q.)	Particle size (nm)
Mo-Cr	0.0628	192.5	-
Au (EB deposition)	0.044	12.8	unable to measure
Au (pulse plating (i))	0.0314	18.15	50-500
Au (pulse plating (ii))	0.0078	9.72	50-500
Au (ultrasonic plating)	0.0035	6.7	250