Epson PrecissionCore

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Technology Clearing the Path

Inkjet printers create output by ejecting droplets of ink directly onto a sheet of paper or other media. Broadly speaking, there are two systems for ejecting ink, piezo and thermal. Piezo systems use piezoelectric elements ("piezo elements") that contract under an applied voltage to eject the ink. Thermal systems heat the ink to cause it to bubble out. Epson’s PrecisionCore printheads are a piezo system.

Ejecting up to 50,000 perfectly controlled droplets of ink per second from each of the hundreds of independently controlled nozzles, these phenomenally precise and accurate printheads are core components in Epson's inkjet printers. Piezo systems are able to more precisely control the volume of ink ejected and the size of individual ink droplets than thermal systems, but piezo printheads are also structurally more complex and difficult to produce.

To maximize printhead quality and productivity, we invested 40 billion yen to build advanced, fully automated production lines in Japan. Outfitted with Epson's own industrial robots, these lines employ a combination of inkjet technology fine-tuned over two decades and MEMS* microfabrication techniques that allow us to process parts on a submicron level.

* Micro-electro-mechanical systems, or MEMS, is a technology for fabricating microstructures, microsensors, microactuators, and microelectronics on a single silicon substrate, glass substrate, or organic material. MEMS also refers to devices that are fabricated in this way.

MicroTFP Print Chip Manufacturing

MicroTFP print chips are manufactured at Epson's Suwa Minami Plant, in Nagano prefecture in Japan. Three silicon chips - a TFP actuator, an ink channel, and a nozzle plate - are bonded together. Ink that enters through the ink flow path of the ink channel is ejected from the nozzles by pump-like action of the TFP actuator. Epson's innovative thin-film piezo technology is used to produce the TFP actuators; its innovative MEMS technology is used to make the chip components.

1. Thin Film Piezo (TFP) technology

An TFP actuator is an extremely thin piezo element formed on a silicon substrate. The piezo element contracts when a voltage is applied to it. This movement provides the power to drive ink, which flows into the ink flow path, from the nozzle plate.

Thin film piezo technology is used to form piezo elements on a silicon wafer in uniform, one-micrometer-thick films. High-quality ceramic crystals that have consistent orientation are formed by sintering using Epson's own crystallization process.

These TFP actuators provide extremely precise control over droplet size and placement and astonishingly accurate prints. That is because their uniform crystal structure means that they maintain uniform displacement when they contract and because the extreme thinness of the piezo film allows for larger contractions and, thus, larger displacement.

Epson manufactures the material for the piezo elements themselves. We also independently developed the chemical reaction process used to synthesize the materials as well as the synthesizing equipment. Having access to the best piezoelectric materials to meet the performance requirements of the piezo elements is a huge advantage for Epson.

2. MEMS technology
High-accuracy, 3D submicron photolithography is a source of Epson's MEMS process strength. In ordinary semiconductor fabrication the dimensional accuracy required for planar processing is high, but the accuracy required for thicknesses is not all that high. Industrial equipment used in the photolithography step normally has several percent variation, but Epson is able to limit this variation anywhere from one-fifth to one-tenth.

This level of accuracy exceeds conventional systems and is among the best in the industry. And it is this that enables us to form extremely fine and intricate TFP actuators, ink channels, and nozzle plates. These are what provide the picoliter-level control over ejected ink volume and the extraordinary precision of dot placement on media.

The nozzles in thermal heads produced on photosensitive resin are only about several microns in length. In contrast, nozzles in MicroTFP print chips produced on silicon wafers may be more than 10 times that length, and this greater nozzle length translates into far more accurate ink droplet placement.