Reference: DS007

Inkwell™ Arrays

This datasheet summarizes the basic physical, dimensional and performance specifications for Inkwells developed by NanoInk. DPN® probe arrays are dipped into micron-sized cavities (or "microwells") containing different inks for coating the probe array tips. NanoInk has designed a series of microwell arrays to meet the assorted needs of inking probes for usable DPN pens. Some arrays are pitch-matched to passive probe arrays, while others accommodate the subtleties of dipping Active Pens. The microfluidic Inkwell delivers different inks to different microwells, allowing the probe arrays to be coated with the same or different inks depending on the array and Inkwell chosen.

The Inkwell die are between 8 and 10 mm square, easily fitting onto the NSCRIPTOR™ DPN System sample puck. Inkwells have 6 reservoirs, corresponding to the 6 writer pens on the Active Pen array. These 6 reservoirs enable the inking of 6 adjacent active writer pens with 6 different inks. The reservoirs are filled with ink using a micropipette. The reservoirs supply inks to the microwells by capillary wicking in micron-sized conduits, or "microchannels." The microchannels run from individual reservoirs (at the periphery of the die) to the center of the die, where they feed the microwells. The system has been designed to keep the microwells full of ink, even as the ink supply slowly evaporates from the reservoir.

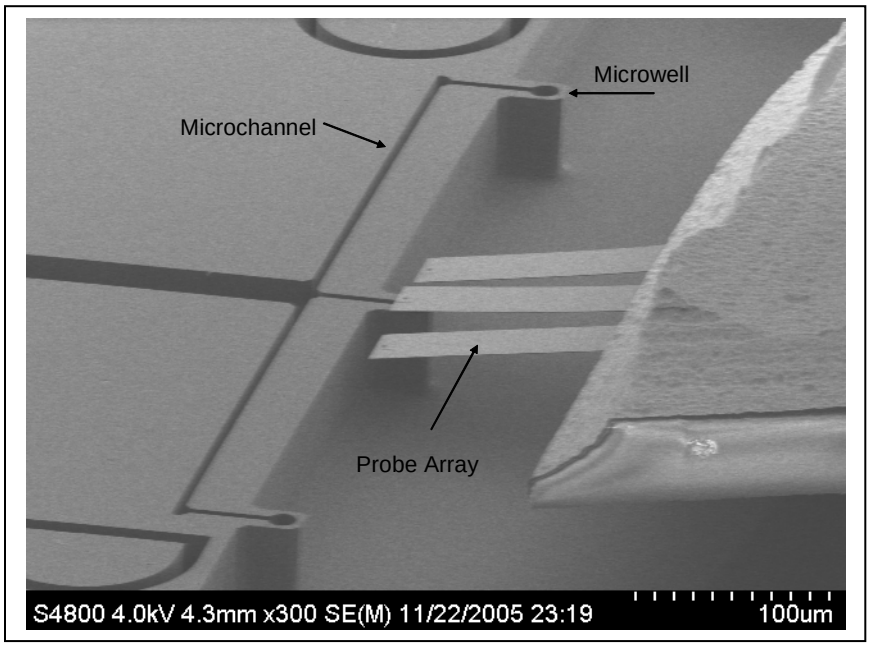
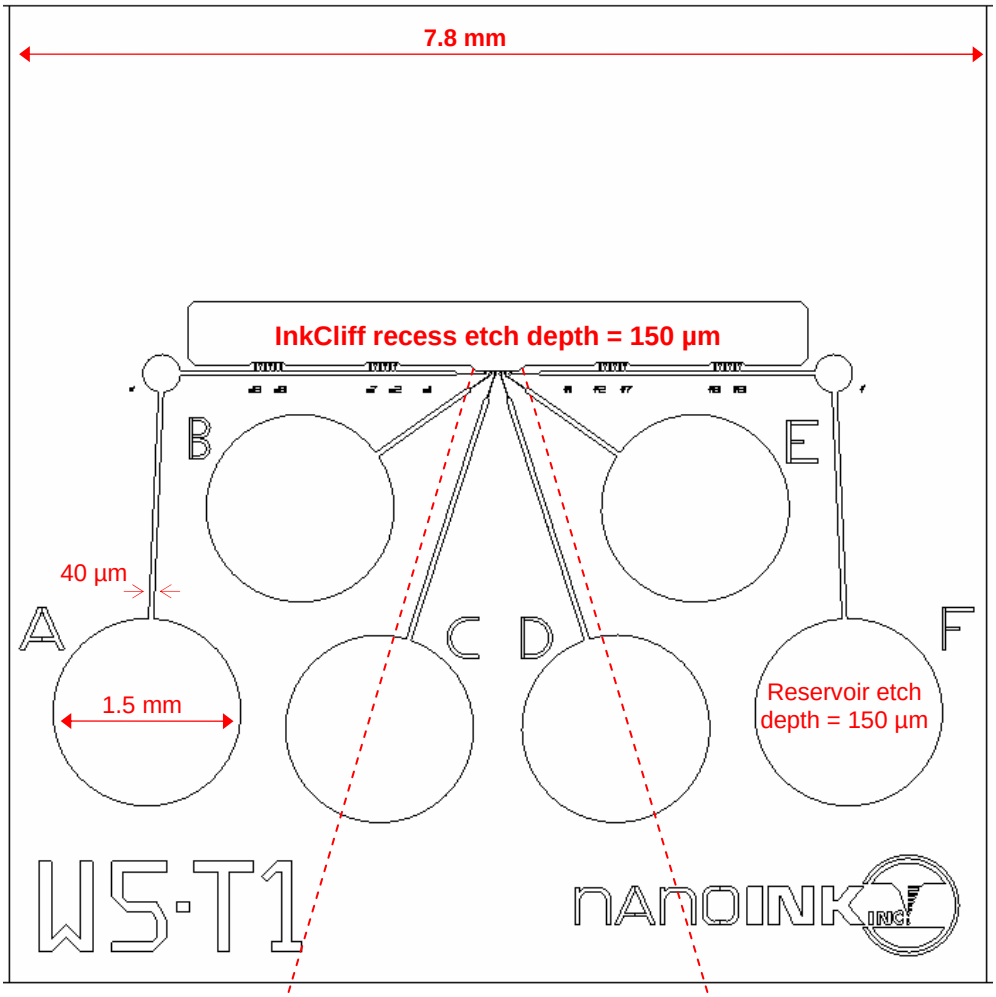


Figure 1: Microwell Array

Figure 1 shows an SEM image of typical microwell array morphology. In another Active Pen Inkwell design (see Figure 2), the "A" and "F" microchannels pass through a single smaller reservoir placed along its length. These smaller reservoirs act as bubble traps to ensure smooth ink flow, and also provide additional ink storage.

Figure 2a: Active Pen Inkwell Layout



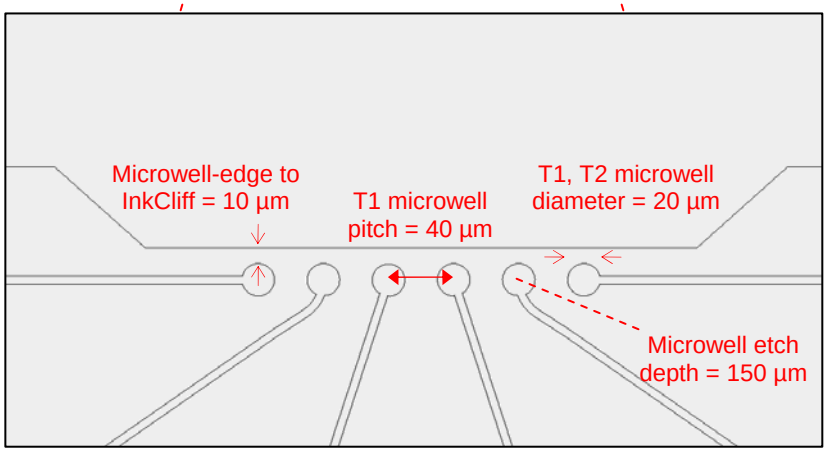


Figure 2b: Zoom of Central Microwell Array

Active Pen Inkwells

Active Pen Inkwells are designed specifically for use with Active Pens, and the basic design is shown in Figure 2. They include several changes from the older passive pen Inkwell designs, notably: (i) InkCliffs to prevent wicking; and (ii) optimized surface coatings to contain ink flow.

Table 1 lists the design element specifications of the Active Pen Inkwell arrays. Figure 2a shows the overall layout of the Active Pen Inkwell chip, with Figure 2b providing more detail. Figure 2a shows a central microwell array, with satellite microwells available along the "A" and "F" microchannels. The central microwell array (Figure 2b) is pitch-matched to either the T1, T2, or T3 active pen arrays. A recessed "InkCliff" region extends along all of the microwells; this region has been etched 150 µm below the surface of the Inkwell.

Figure 3 illustrates how the InkCliff aids ink dipping – it provides a barrier to prevent ink from wicking along the underside of the cantilever. By keeping the microwell close to the edge of the InkCliff, wicking is limited to the area immediately surrounding the tip (shown in Figure 4). Finally, enhanced hydrophobic surface coatings inhibit ink from spilling out of the reservoir, microchannel, and microwell, while hydrophilic channel coatings work to keep the ink contained. (Note: these inkwells are compatible with hydrophilic inks only.)

Table 1: Nominal Dimensions DPN Active Pen and Universal Inkwells

Inkwell Type	*Active-Only T1*	*Active-Only T2*	*Active-Only T3*	*Universal Inkwells*	
				Active Section	*Passive Section*
microwell pitches (µm)	40	30	23	400	35
microwell diameter (µm)	20	20	15	20	
microwell etch depth (µm)	150	150	150	85	
distance: edge of microwell to InkCliff (µm)	10	10	10	6	6 / (InkTrough-to-InkCliff = 20)
InkCliff recess etch depth (µm)	150	150	150	85	
microchannel width (µm)	40	40	40	40 / (6 near microwells)	InkTrough width = 40
microchannel etch depth (µm)	150	150	150	85	
reservoir diameter (mm)	1.5	1.5	1.5	2.0	
substrate size (mm)	7.8 x 7.8	7.8 x 7.8	7.8 x 7.8	9.5 x 9.5	

Universal Inkwells

The Universal Inkwells represent the latest generation of inkwell development, and they replace all previous inkwell types. The design accommodates active pens, plus E and F-type passive pens, all on one chip. The chip has separate active pen and passive pen dipping areas. These Inkwells incorporate the design changes noted above, and introduce several improvements:

Active Pen Area of Universal Inkwells

- Compared to previous designs, these microwells now protrude from the surrounding chip, providing an "inking peninsula" of sorts to isolate the ink dipping event and prevent wicking or contamination.
- The microwell pitch has been increased to 400 µm, which actually proves ideal for active pen dipping. In this process, there is no need to dip adjacent active writer pens simultaneously. In fact, this is discouraged as it increases the chance of wicking and contamination. Instead, each writer pen is dipped in succession, first inking pen #2 in an "A" microwell, and then translating across the chip to ink pen #3 in a "B" microwell. The 400 µm pitch between same-ink microwells ensures that other pens in the array will not be inadvertently inked.
- The microwell-InkCliff distance has been decreased to 6 µm. This optimized distance reduces the overlap of the active writer pen heat spreader over the microwell, which reduces ink heating effects.
- The recessed InkCliff area has been extended to the back edge of the chip. This larger region provides ample clearance for the probe chip during inking.

Figure 3: Active Pen Dipping Process using InkCliff

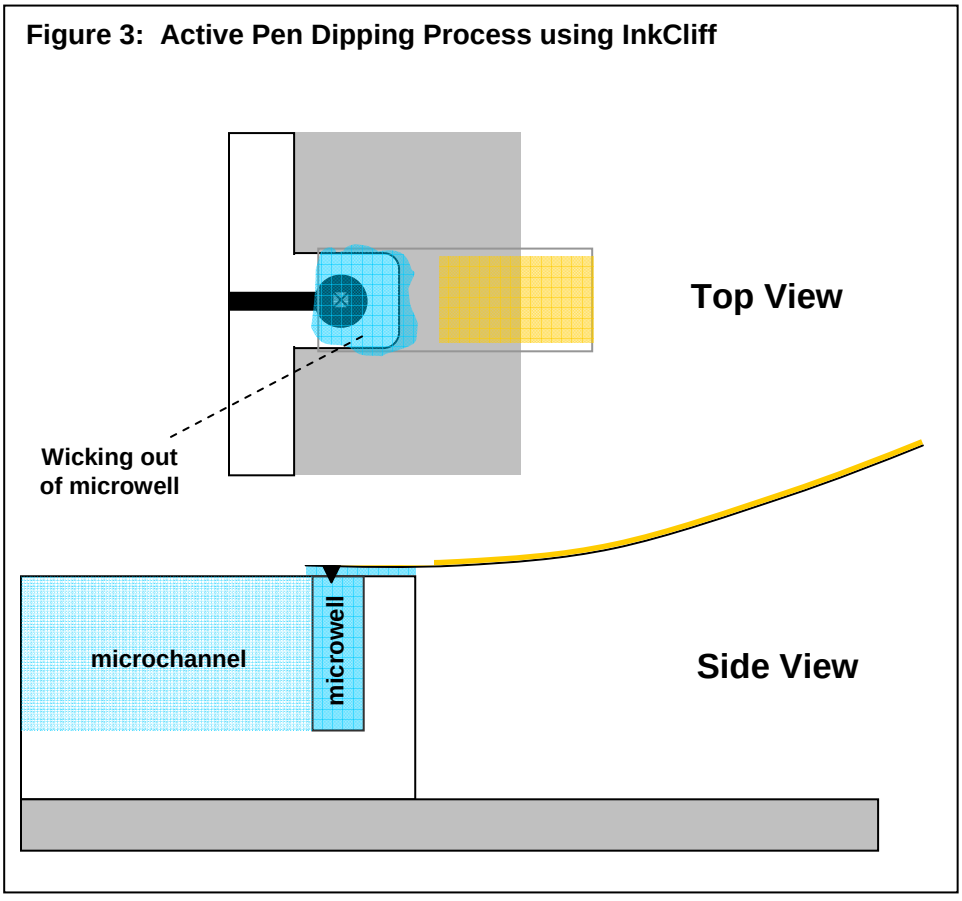


Figure 4a: Universal Inkwell Layout

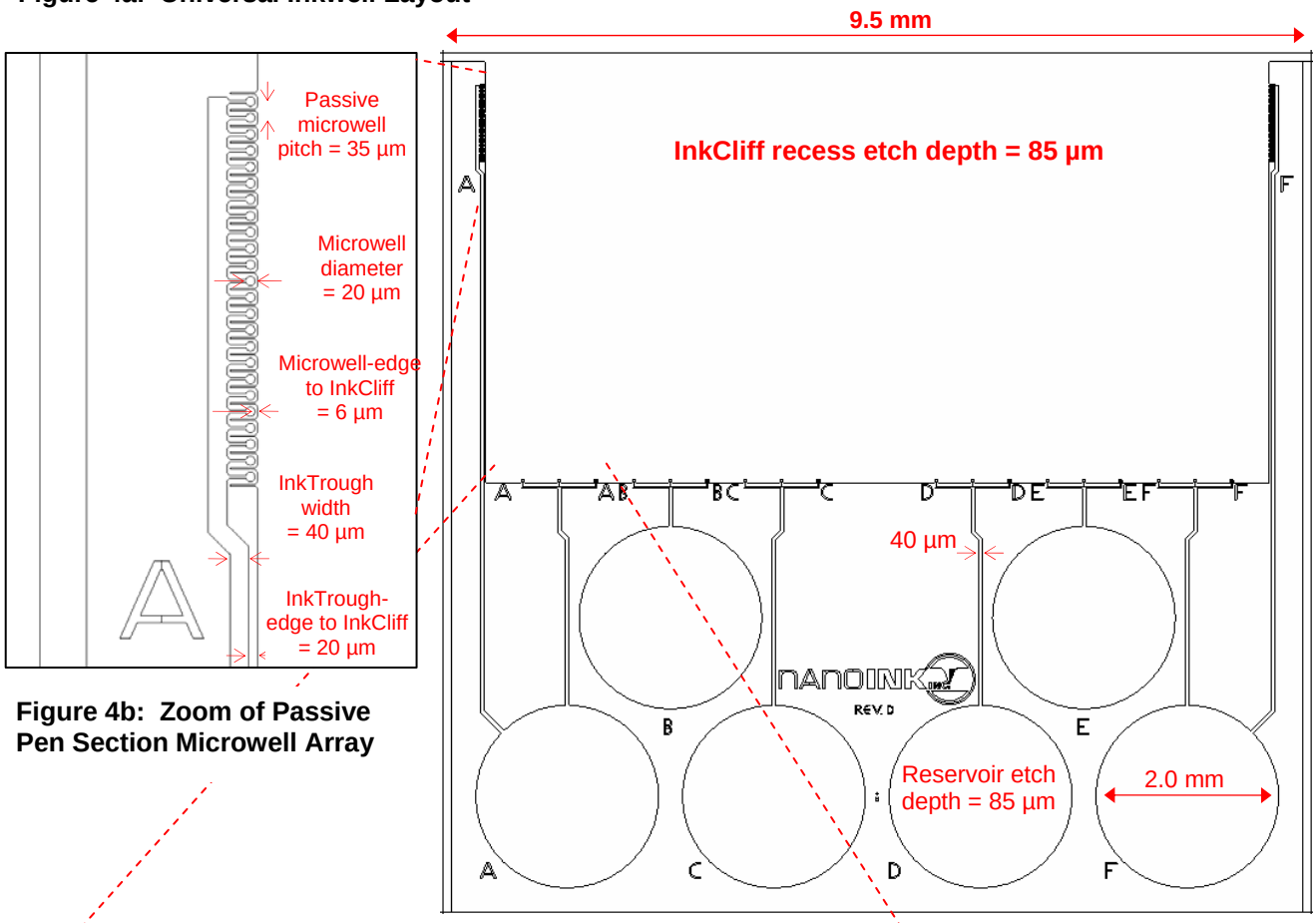


Figure 4b: Zoom of Passive Pen Section Microwell Array

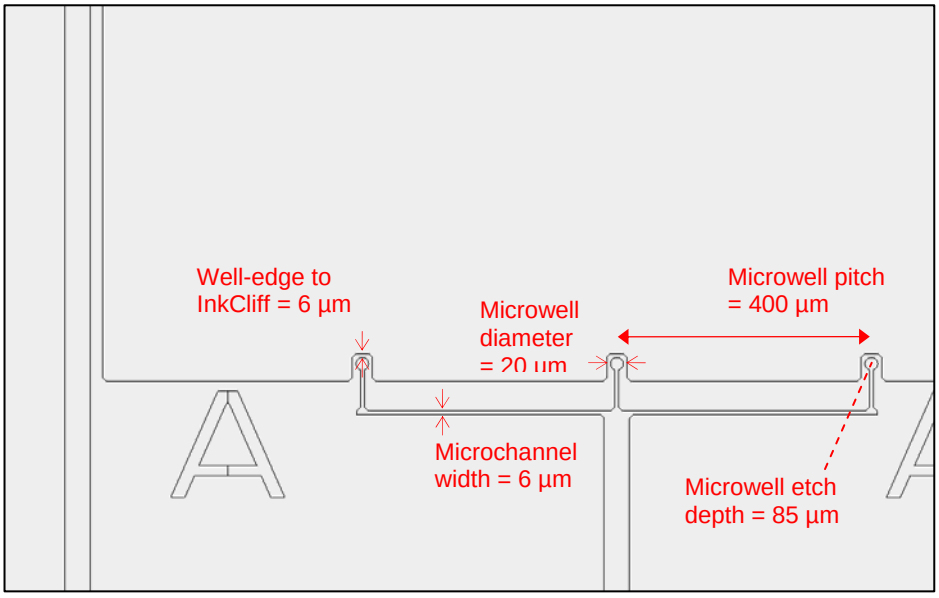


Figure 4c: Zoom of Active Pen Section Microwell Array

Passive Pen Area of Universal InkWells

- The "A" and "F" active pen reservoirs also feed the passive pen section of the chip. To use the "A" passive pen section of the chip, rotate 90 degrees counter-clockwise. (Clockwise for "F.") These areas include the regular microwell arrays, and InkTroughs.
- InkTroughs are a new feature provided to enable quick and easy inking of passive probe arrays with the same ink. Positioning the InkTrough near the edge of an InkCliff prevents ink from wicking to the underside of these arrays, while still ensuring that all pens are inked. The InkTrough is long enough to accommodate multiple adjacent probe chips for massively parallel DPN.
- The passive microwell arrays contain 24 microwells spaced 35 µm apart. This array accommodates all of the E and F-type passive probe arrays. The 24 microwells exactly match the 24 writer pens of the A-26 array. (The D-type A-26 probe array is identical, and will work with these microwells too.) The A-3A and A-3C arrays have 70 µm pitch probes, and can be inked by lining up every other microwell. The A-18 probes also have 70 µm pitches: half of the array is dipped initially (lining up every other microwell), then the array is translated 840 µm (24 wells x 35 µm pitch) and the remaining tips are inked. The A-52 probe array is intended for inking via the InkTrough only. Additionally, probe arrays type A-D can be inked passively using the InkTrough; this has proven more effective than using the 1st generation inkwells.

For more information including pricing, please contact NanoInk Sales Department at sales@nanoink.net or 1-847-679-NANO.