Supplementary Information: FLASH: A Rapid Method for Prototyping Paper-Based Microfluidic Devices

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Preparation of UV light-sensitive Photoresist

We combined EPON SU-8 resin (130 g, Hexion Specialty Chemicals) with propylene glycol methyl ether acetate (PGMEA) (134 mL, Sigma-Aldrich) in a glass jar, and we stirred the mixture on a stir plate for 48 h at room temperature until the resin was completely dissolved. We added a 50% solution of mixed triarylsulfonium hexafluorophosphate salts in propylene carbonate (20 mL, Sigma-Aldrich) to the dissolved resin and stirred for an additional hour. The photoresist was stored at room temperature in a sealed jar covered with aluminum foil.

Preparation of FLASH Paper

We poured photoresist onto a piece of paper and spread the photoresist evenly around the paper using a wooden rolling pin. We baked the photoresist impregnated paper on a digital hotplate set to 130 °C until the paper was dry to touch (5–10 minutes depending on the paper). Alternatively, the paper could be dried at room temperature, but longer drying times are required (~20 minutes for Whatman chromatography paper No. 1). The paper was cooled to room temperature. One face of the paper was covered with an adhesive transparency film (Computer Grafix clear adhesive backed ink jet film or clear adhesive backed laser printer/copier film); the other face of the paper was covered with a sheet of black construction paper. The photoresist-impregnated paper was cut slightly smaller than the transparency film and construction paper so that the transparency sheet could be adhered to the construction paper around the edges of the photoresist-impregnated paper. FLASH paper was stored at room temperature wrapped in aluminum foil.

Printing Patterns onto FLASH Paper

Ink-jet printed patterns: Designs for microfluidic devices were prepared using CleWin (PhoeniX Software). The designs were saved as post-script files, converted to PDFs, imported into Adobe®Photoshop® at 600 DPI resolutions and printed directly onto the transparency face of FLASH paper using an inkjet printer (HP Deskjet D2430 set to print at maximum resolution using black ink only).

Photocopied patterns: FLASH paper (prepared using a laser printer/copier transparency film) was loaded into the paper tray of a photocopying machine (Imagistics IM4511). The patterns were printed onto white paper using the settings describe above and photocopied onto the transparency face of FLASH paper using the default settings on the photocopier.

Hand-drawn patterns: Patterns were hand-drawn on the transparency face of FLASH paper using a black pen (Sarstedt black permanent pen) and a stencil cut from a transparency sheet using a laser cutter (Universal Laser VL-300 50 Watt Versa Laser).

FLASH Patterning with UV light

FLASH paper was placed in a UV light curing chamber (Unitrin Raven equipped with a Unitrin Intel-ray 600 UV lamp), with the tray in the chamber at the lowest setting. The paper was irradiated with UV light at 100% intensity. Exposure times were set according to the type of paper being patterned. The FLASH paper was removed from the chamber immediately after exposure, and the transparency film and the construction paper were removed from the photoresist-impregnated paper. The photoresist-impregnated paper was placed on a hotplate set to 130 °C, baked for 5 minutes, and cooled to room temperature.

We developed the patterns by soaking the paper in a bath of acetone (1 min), followed by a rinse in acetone (1×) and a rinse in 70% isopropyl rubbing alcohol (30% water in propan-2-ol, 2×). The paper was blotted with paper towels between the two rinses with isopropyl alcohol. After the final rinse, the paper was blotted between paper towels and dried under ambient conditions (5 min).

FLASH Patterning with Sunlight

FLASH paper was placed outdoors on a flat surface and in direct sunlight for 6 min. We patterned paper using sunlight in Cambridge, MA, on a sunny summer day (June 25, 2008, UV index = 7) between 11 AM and 1 PM. After exposure, the transparency film and the construction paper were removed from the photoresist-impregnated paper, and the photoresist-impregnated paper was developed as described above.

Measuring Dimensions of Features

Fourty microliters of 1-mM Erioglaucine (aqueous blue dye) were added to the sample reservoirs of the devices shown in Figure 2 to determine the smallest functional channel and the smallest functional barrier. The dye was allowed to wick into the devices for 10 min, and excess dye was absorbed with a paper towel. The width of the smallest channel that was filled with fluid and the width of the smallest barrier that prevented fluid from crossing it were measured by imaging the patterns using a Nikon digital camera

(DXM1200) attached to a stereomicroscope (Leica MZ12). We analyzed the images using Adobe® Photoshop®.