Electronic Supplementary Material (ESI) for Lab on a Chip

Paper-based microfluidics with an erodible polymeric bridge giving controlled release and timed flow shutoff

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Supplementary Information

1. Proposed process to scale-up production of the pullulan shutoff system

In order to scale this process, it is necessary to have simple steps through which the channels can be created. Here a simple approach is proposed to create tens of pullulan shutoff systems quickly and easily. This process is illustrated step-by-step in Figure I as:

Step 1- Cut paper (Figure I-A): The initial step is to create holes in the paper (using a customized hole-punch). This can be done by hole punching a strip across each channel width.

Step 2 – Apply adhesive (Figure I-B): Using a stencil cover to reveal only the area around the holes in each channel, an adhesive can be applied. The process of spraying on the adhesive is then to be repeated on the other side.

Step 3- Place PET Film (Figure I-C): Next, the PET film is cut to strips that allows coverage of the channel holes across the entire paper sheet.

Step 4- Place pullulan film (Figure I-D): The pullulan solution can be casted onto trays to produce letter-sized films. Then, the pullulan film is cut to a size slightly larger than the holes; following this, these strips are placed onto the paper with the already applied adhesive securing them**.**

Step 5- Cut Paper (Figure I-E): Finally, the paper with the pullulan and PET are cut; and 48strips come out of a letter size paper sheet.

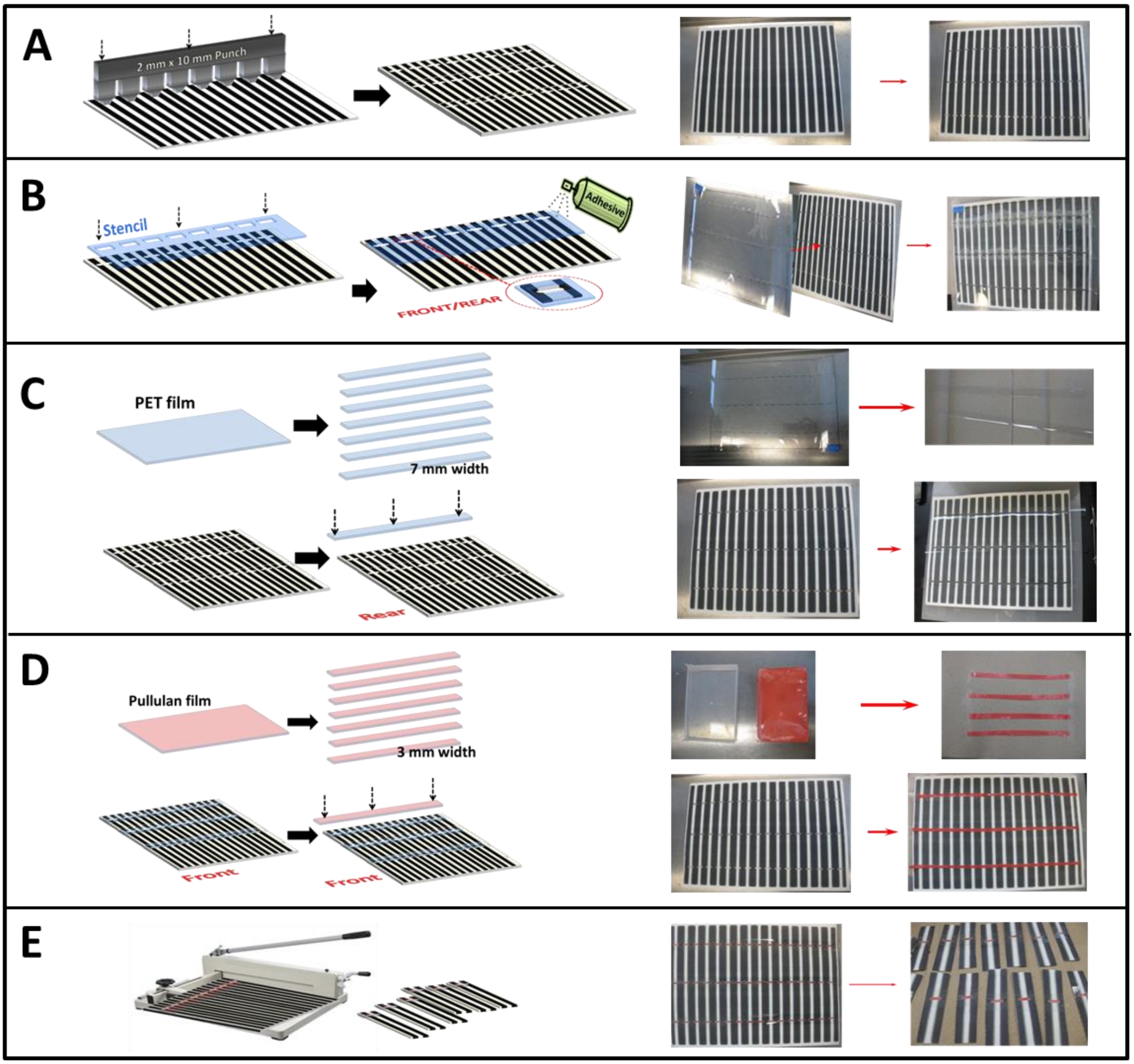

Fig. I Step-by-step demonstration of the proposed approach for scaling-up the pullulan shutoff system. Schematic cartoons of these proposed steps are depicted in the left column, and the related real images are shown in the right side.

2. Preparing pullulan films with well-defined thicknesses

The relationship between the volume of pullulan solution cast andthe thickness of the resulting films is shown in Figure II. It is evident from this Figure that there is a linear relationship between the volume of pullulan solution added and the thickness of the film. Thus, the film thickness can be easily controlled by adjusting the amount of pullulan solution used.

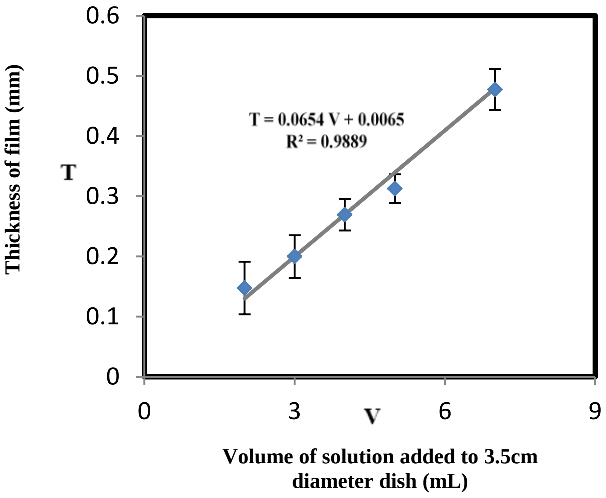

Fig.II Amount of pullulan solution cast vs. thickness of resulting film.

3. Multidirectional Flow and Sequential Release

Apart from serving as a flow shutoff system, the pullulan bridge can also facilitate multidirectional flow and sequential release of reagents. Figure III depicts colored pullulan films layered and adhered with a thin layer of water to form a layered bridge. Figure III also shows water flow through the layered bridge, which results in the bottom dye (yellow) being delivered farther than the top dye (red). These results are expected, as the bridge dissolves from the bottom upwards, releasing the dyes in order. This demonstrates the possibility of not only the release of multiple reagents but the sequential release of reagents using pullulan films.

In addition, this pattern shows flow in both a lateral direction through the paper and vertical direction through the pullulan film simultaneously. Controlled multidirectional flow is a unique capability of the pullulan bridges.

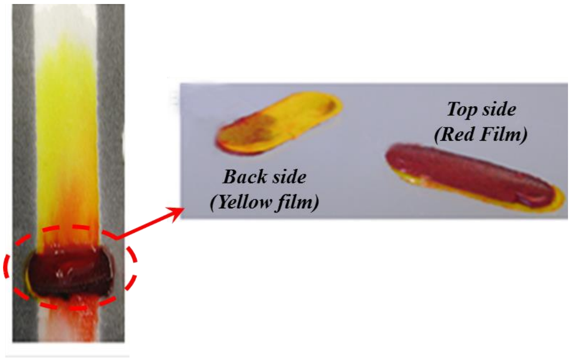

Fig.III Multidirectional flow, a unique capability of the pullulan bridges, is demonstrated by showing a two-tone layered red and yellow bridge, and the flow through this dissolvable bridge.