Supplementary material

BioPen: direct writing of functional materials at the point of care

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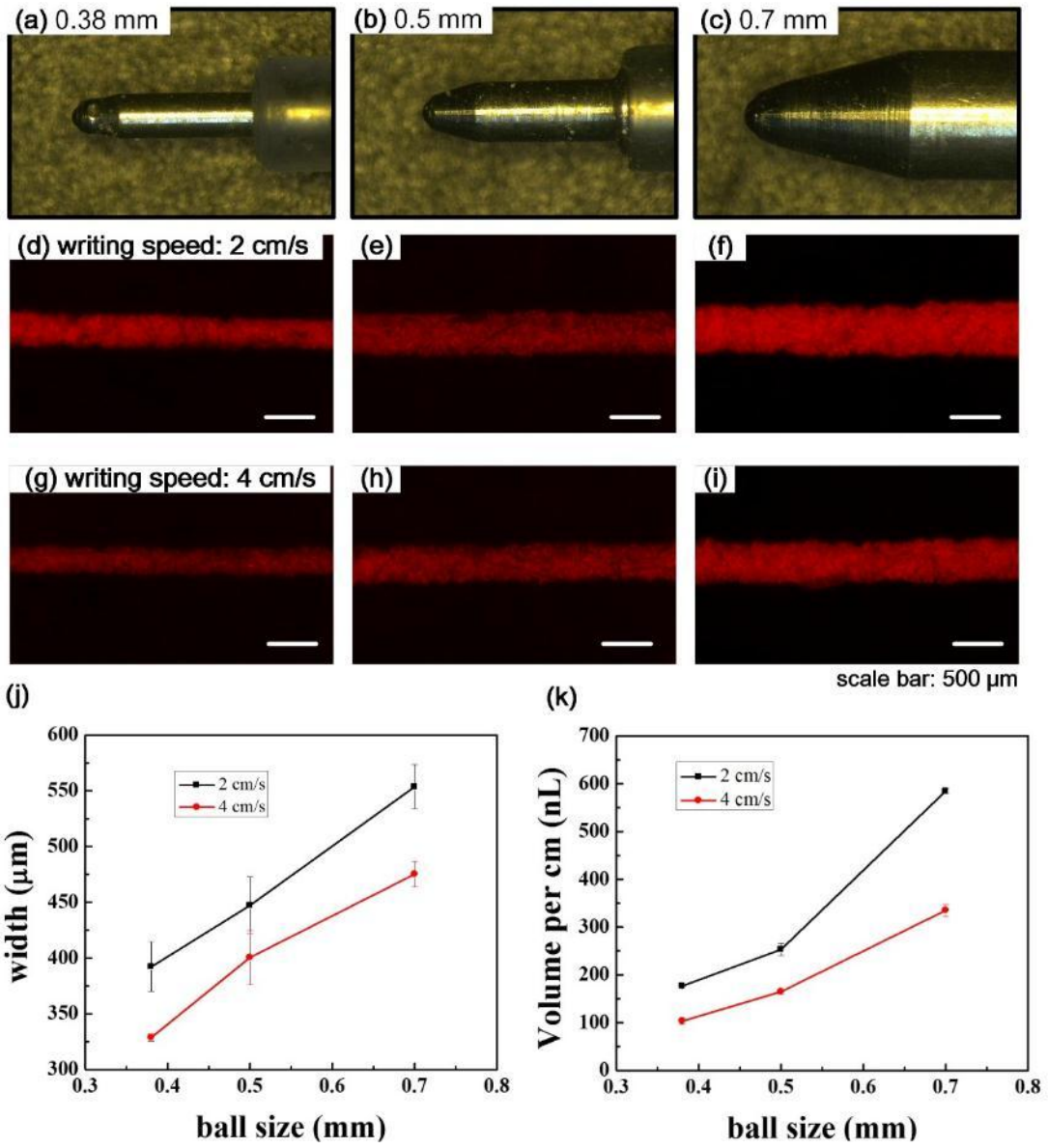

Figure S1. Line width and volume deposited per unit line length could be controlled through the choice of steel ball diameter (a-c) and writing speed. This was assessed by measuring rhodamine lines on printer paper that were written with differently sized steel balls and at different writing speeds (d-i). Line width **(j)** and volume deposited per unit line length **(k)** increased with both the diameter of the steel ball and decreased with the speed of writing.

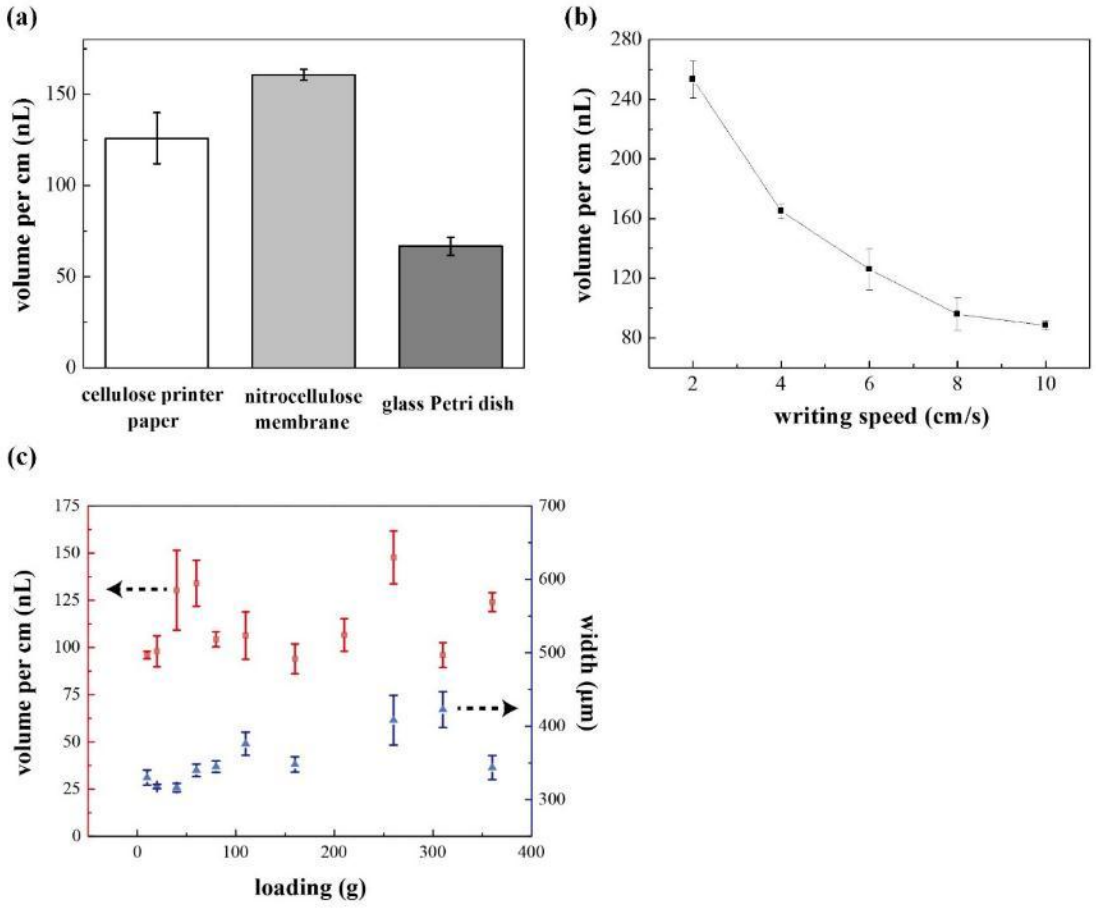

Figure S2. The volume of functional biomaterial "ink" deposited per centimeter of line length varied with (a) the substrate, **(b)** the writing speed and **(c)** pressure. Results shown in (a) are for rhodamine "ink" written at 6 cm/s using a 500 μm diameter steel ball. Results shown in (b) are for this same ink and pen, written at a range of speeds. Results shown in (c) are for this same ink, speed and pen, written at a range of pressure.

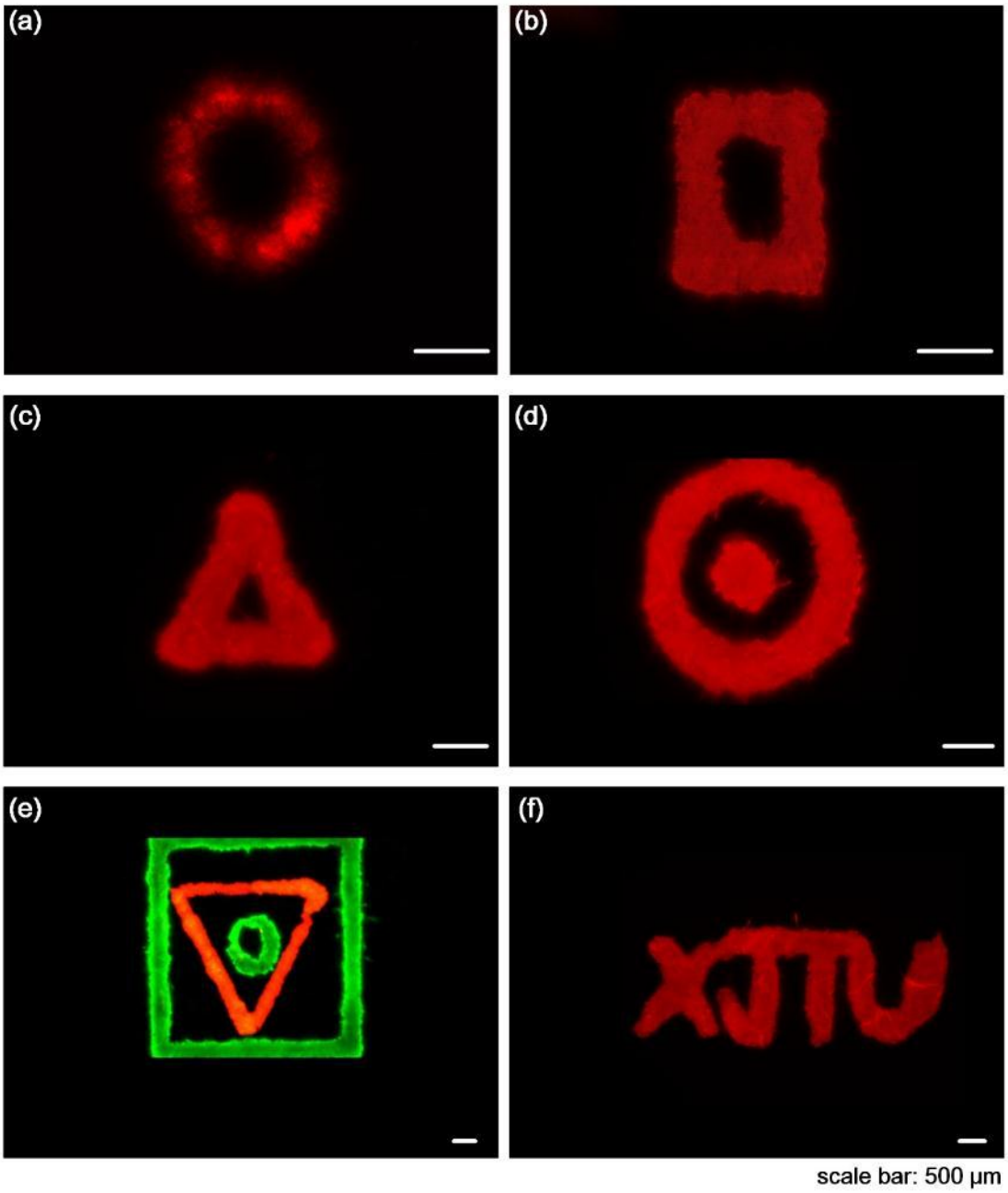

Figure S3. BioPen shows the ability to write functional "inks" with the same degree of user-dependent accuracy as conventional inks. This was demonstrated by writing rhodamine (red) and FITC (green) onto a cellulose printer paper in single-step patterning of simple shapes (a-c) , two-step patterning of a point in circle **(d),** three-step patterning of a circle, triangle, and square **(e)**, and seven-step patterning of the initials "XJTU" **(f)**.

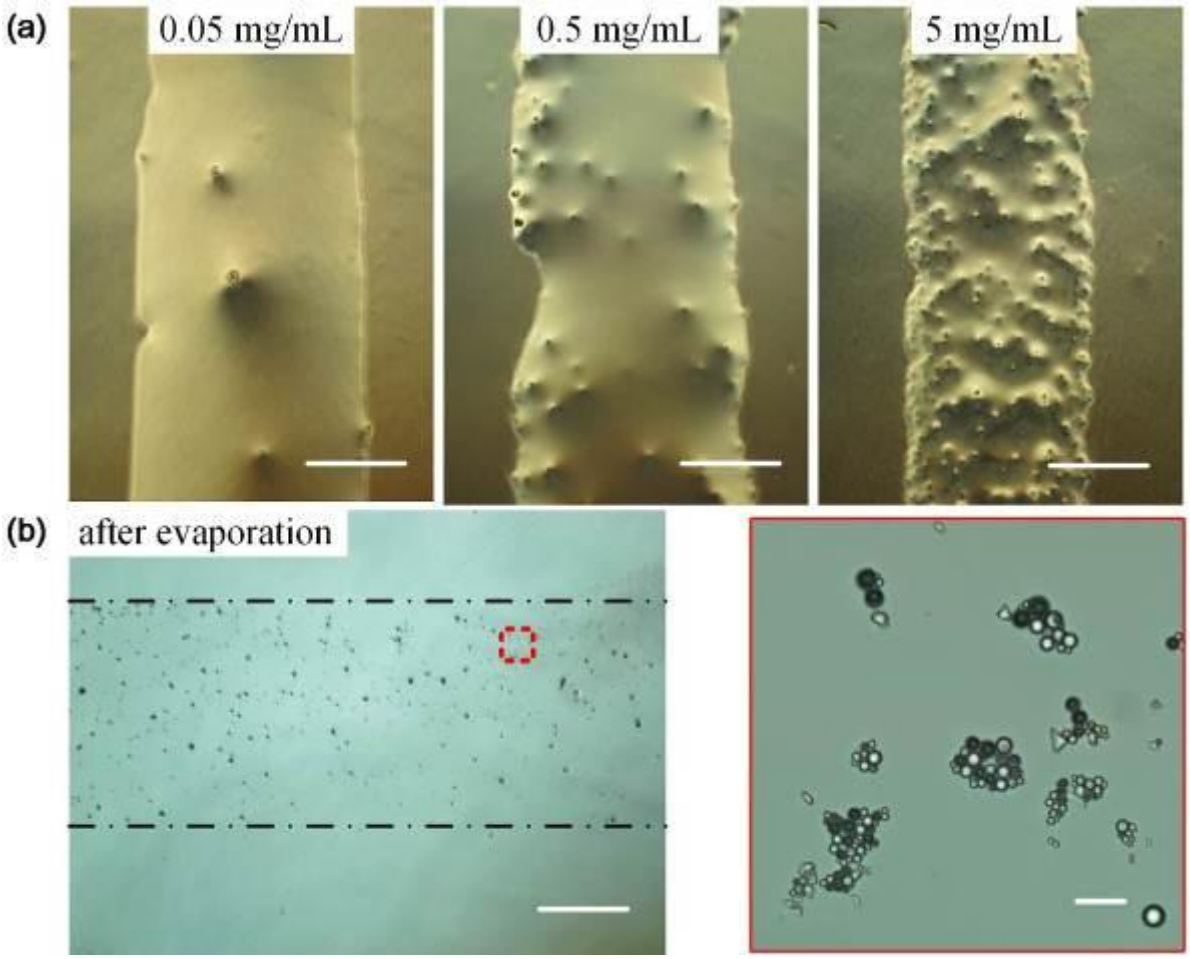

Figure S4. Glass beads can be dispersed in relatively small clusters using BioPen. **(a)** Phase-contrast micrographs of 9-13 μm diameter glass beads written with different concentrations on glass Petri dishes. Scale bar: 500 μm. **(b)** Phase-contrast micrographs of glass beads after evaporation. The dashed line indicates the boundary of liquid. Scale bar: 500 μm. Note that clustering occurred during evaporation, as seen in the enlargement at right of a region within the red dashed frame in left photo (scale bar: 20 μm).

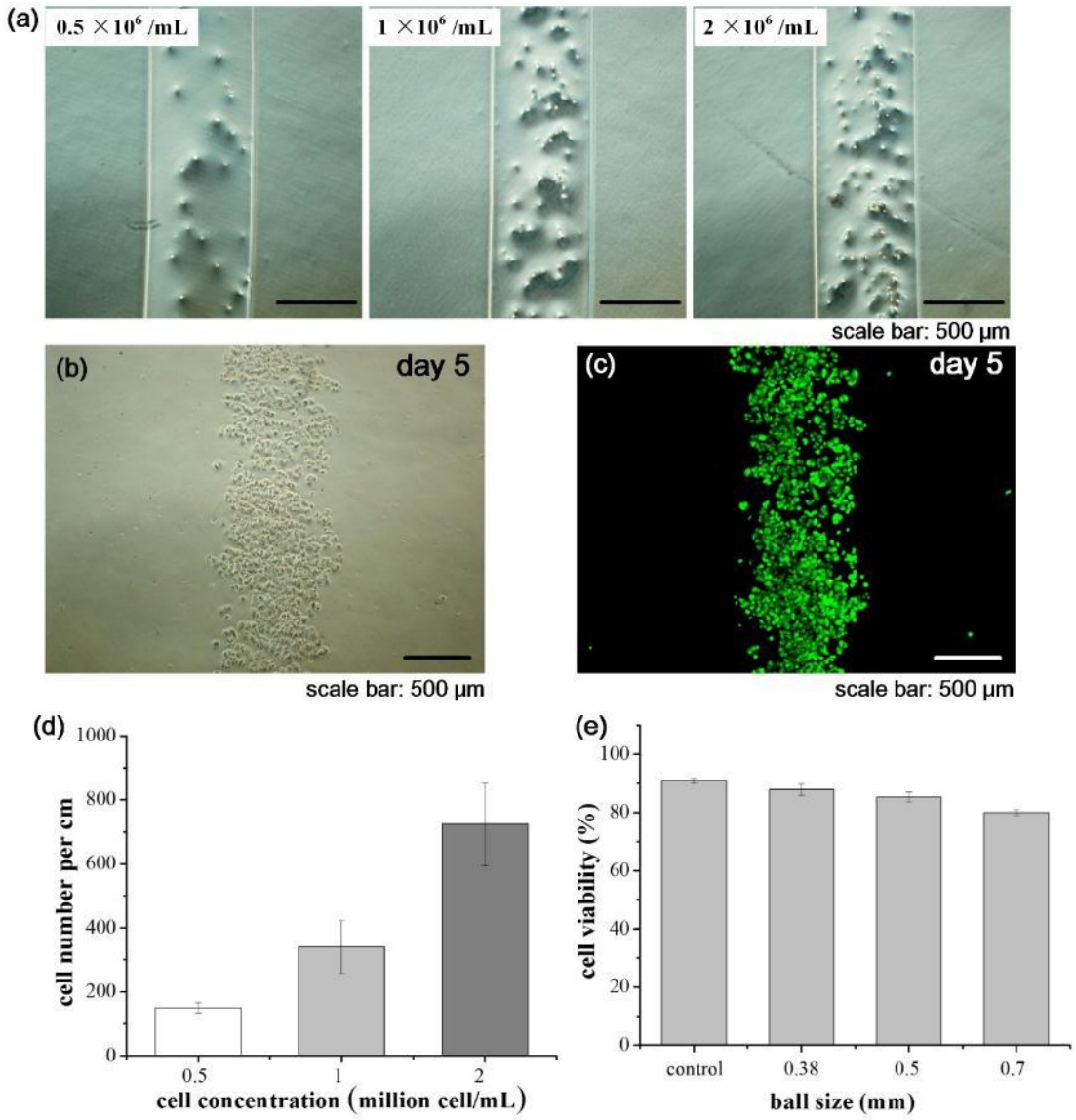

Figure S5. BioPen can pattern cells accurately with only a minor reduction in cell viability. (a) Phase-contrast micrographs of MCF-7 malignant cells written with different cell concentrations on Petri dishes. Phase-contrast micrographs **(b)** of MCF-7 cells after 5 days of culture show a well spread population, and corresponding live/dead staining showed high cell viability **(c)**. **(d)** The number of cells written per centimeter varied approximately linearly with the concentration of cells in the "ink." **(e)** Cell viability after writing decreased slightly relative to control (non-written cells). This decrease was a function of the diameter of the steel ball.

Table S1. Oligonucleotide sequences used for point-of-care diagnostics.

Name	Sequence
Detector probe	5’-CACAACAGACGGGCACACACTACT-$(CH_2)_6$-HS-3’
Capture probe	5’-Biotin/GTCTGAGGGATCTCTAGTTACCAG-3’
Control probe	5’-AGTAGTGTGTGCCCGTCTGTTGTG/Biotin-3’
Target nucleic acid	5’-AGTAGTGTGTGCCCGTCTGTTGTGTGACTCTGGTAACTAG AGATCCCTCAGAC-3’
Control nucleic acid	5’-GCCTCAATAAAGCTTGCCTTGAGTGCTTGTGGAAAATCTC TAGCAGTGGCGCC-3’