ACCSCIENCE PUBLISHING

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RESEARCH ARTICLE

Experimental and numerical approaches for optimizing conjunction area design to enhance switching efficiency in single-nozzle multi-ink bioprinting systems

Supplementary File

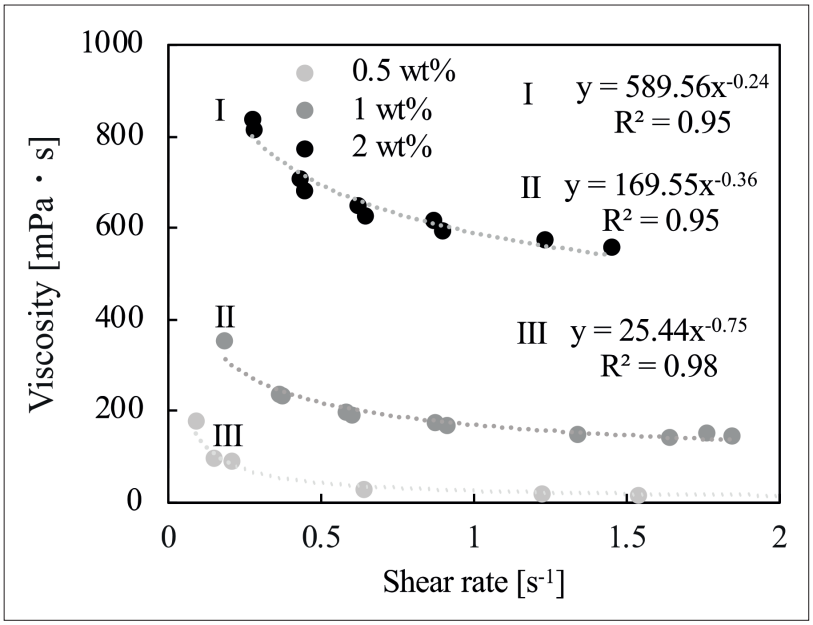

Figure S1. Viscosity profiles of 0.5, 1.0, and 2.0 wt% sodium alginate (SA) aqueous solutions.

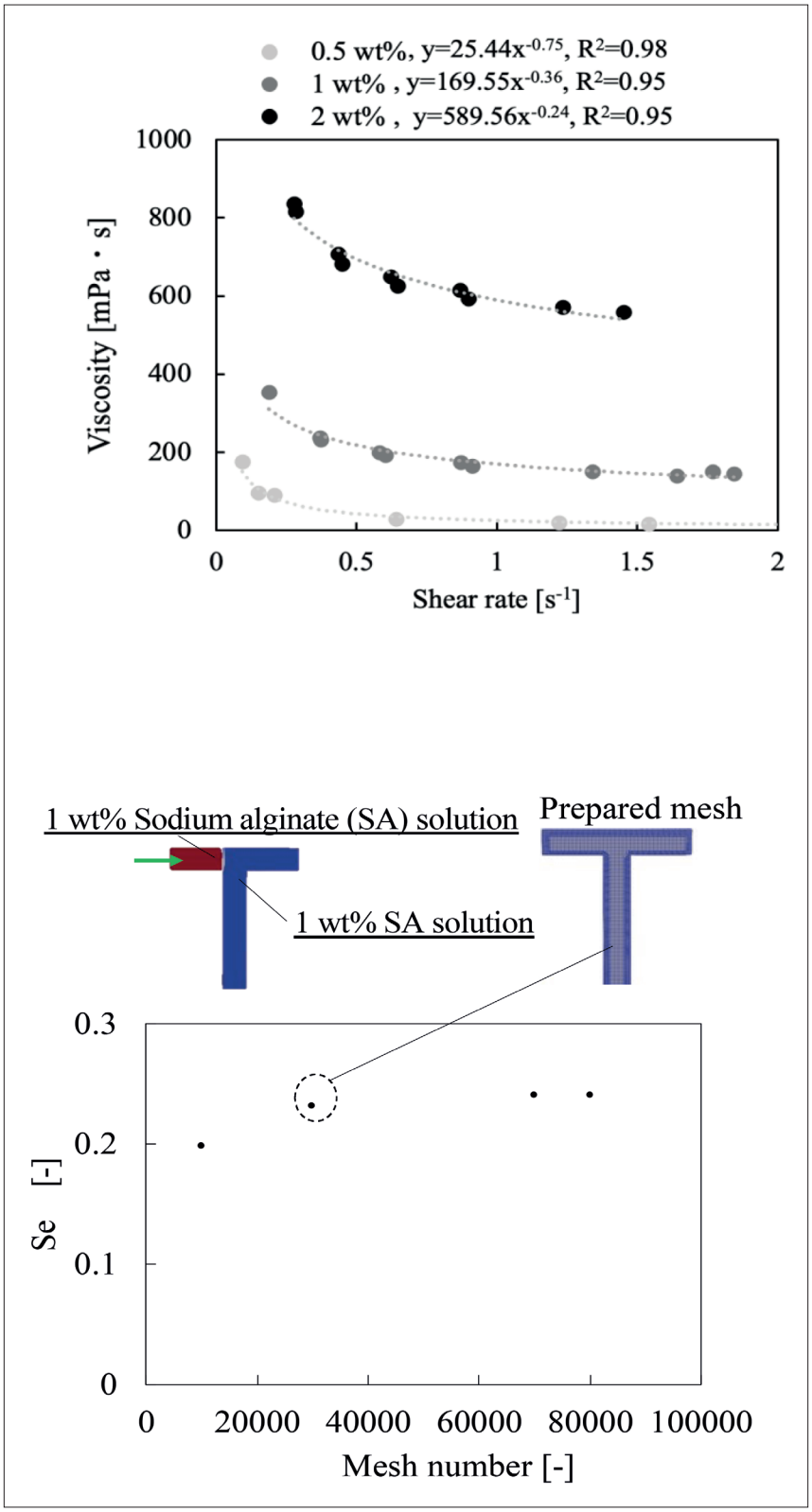

Figure S2. Effect of mesh number on the convergence of switching efficiency (*Se*).

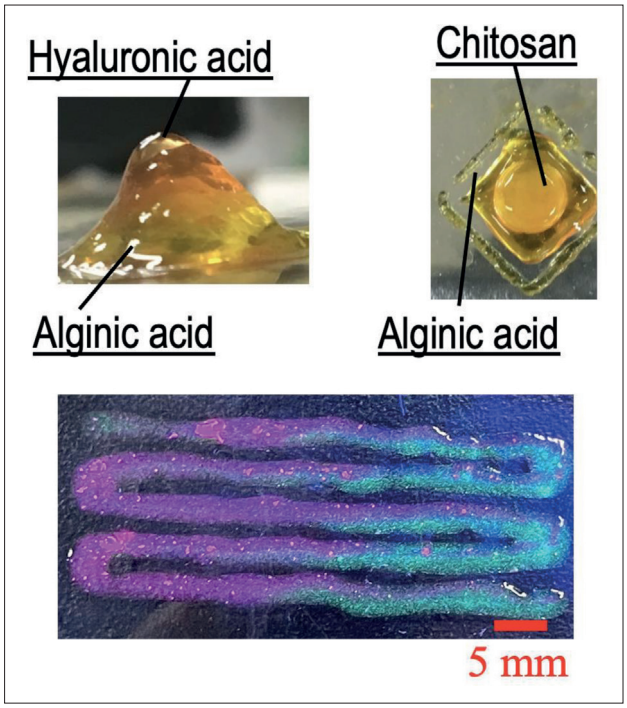

Figure S3. 3D-printed structures obtained using single-nozzle 3D printing system. (Top-left) A pyramid structure of sodium alginate (SA)-Ph and hyaluronic acid-Ph. (Top-right) A cube and tube structure of chitosan-Ph and SA-Ph. (Bottom) The line structure of SA aqueous solutions.

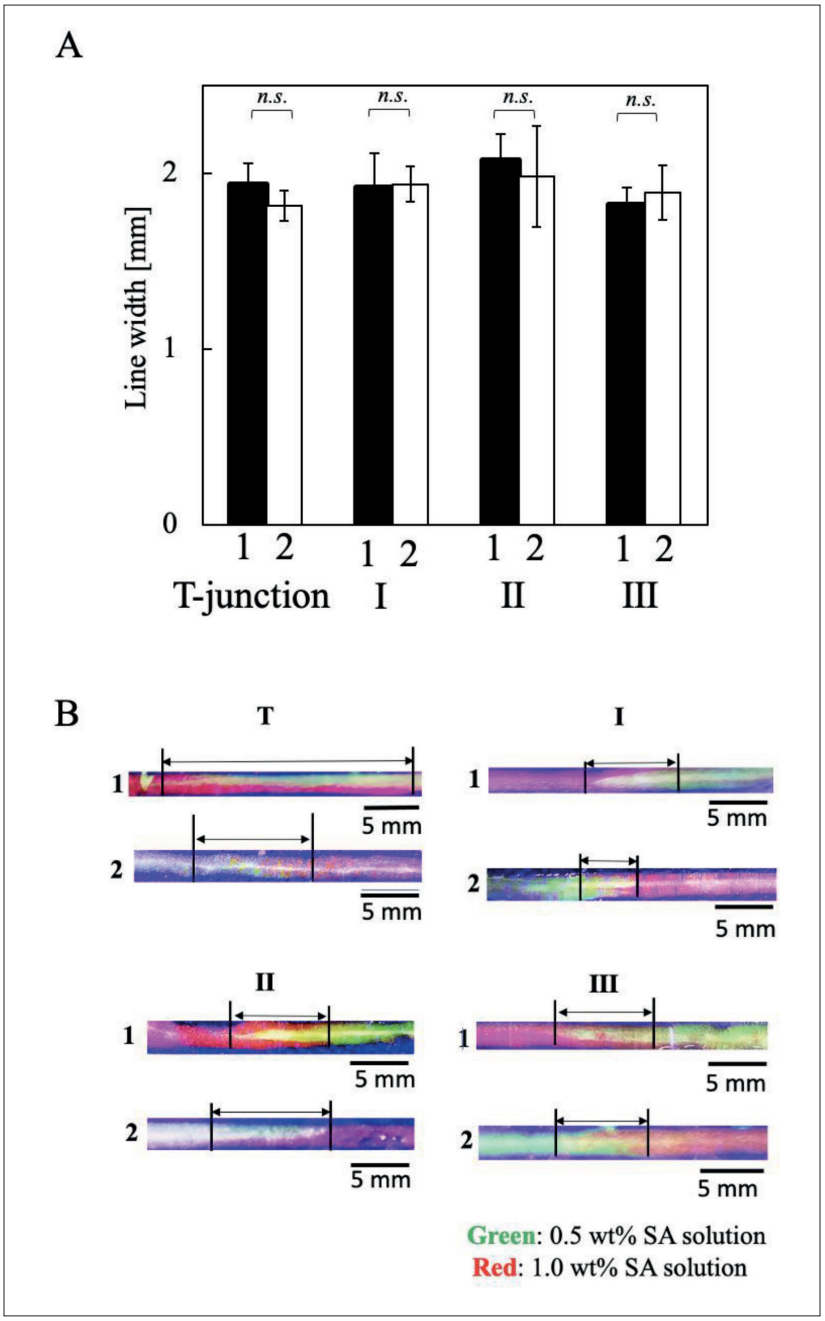

Figure S4. Line structure printing using the nozzles proposed by numerical simulation for 0.5 and 1 wt% SA inks. (A) Line widths of transition area. Data are presented as mean ± S.D.; *n.s.*: $p > 0.05$. (B) Photos of line structures of 0.5 and 1.0 wt% sodium alginate (SA)-Ph inks printed using T-junction and asymmetrical nozzles presented in **Figure 5A**.

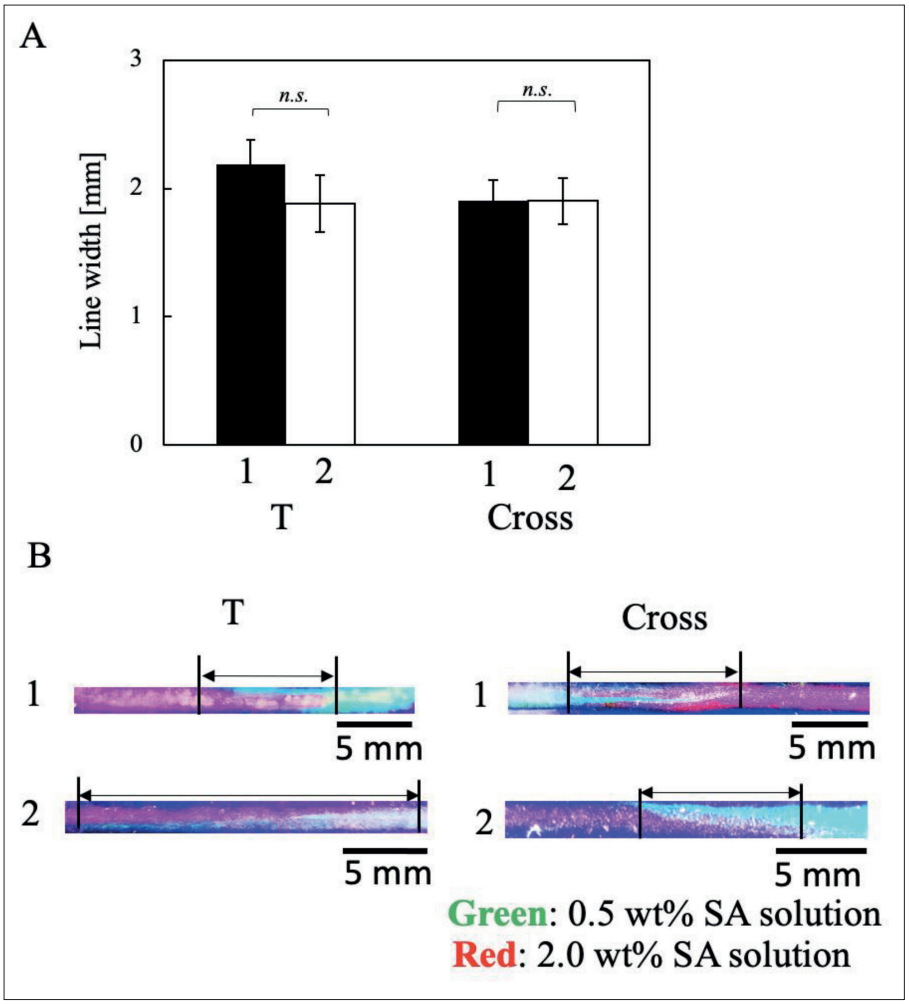

Figure S5. Line structure printing using the nozzle proposed by numerical simulation for 2.0 and 0.5 wt% SA inks. (A) Line widths of the transition area. Data are presented as mean ± S.D.; *n.s.*: $p > 0.05$. (B) Photos of line structures of 0.5 and 1.0 wt% sodium alginate (SA)-Ph inks printed using T-junction and cross nozzles presented in **Figure 6A**.

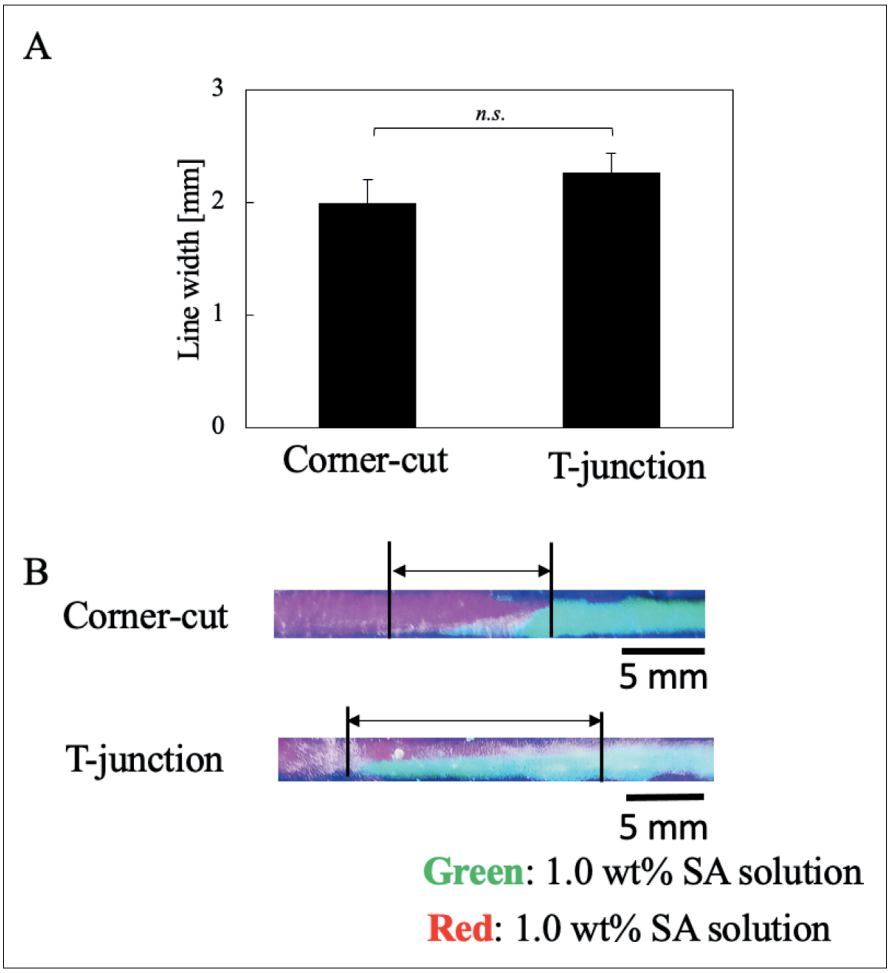

Figure S6. Line structure printing using the nozzle proposed by numerical simulation for 1.0 SA ink. (A) Line widths of the transition area. Data are presented as mean ± S.D.; *n.s.*: $p > 0.05$. (B) Line structures of 0.5 and 1.0 wt% sodium alginate (SA)-Ph inks printed using T-junction and cross nozzles presented in **Figure 7A**.

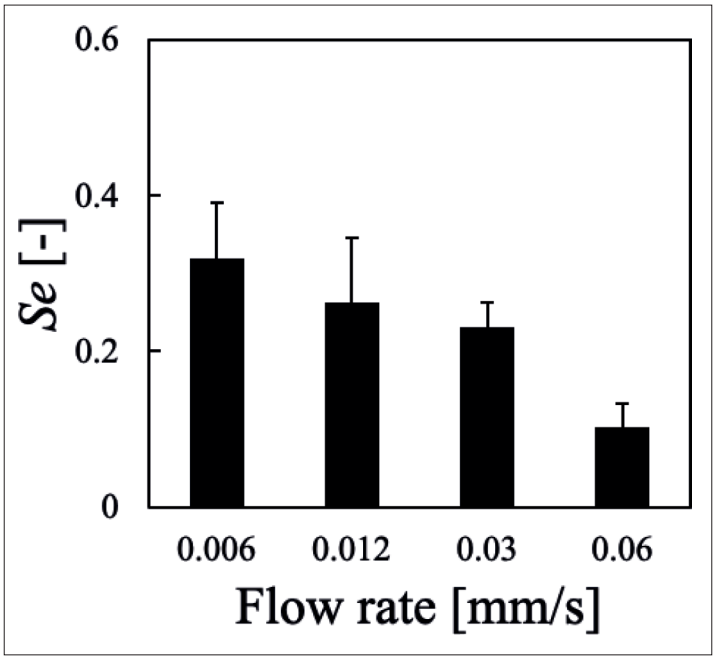

Figure S7. Effect of flow rate on switching efficiency (*Se*). $n = 5$; data are expressed as mean ± S.D.