

Table S1. Parameters used for fabricating PP foams with different densities.

PP foam density, (g/cm ³)	0.109	0.098	0.064	0.038
CO ₂ loading (%)	2	2	2.5	4
Extruder throughput (kg/h)	7	7	5	7.5

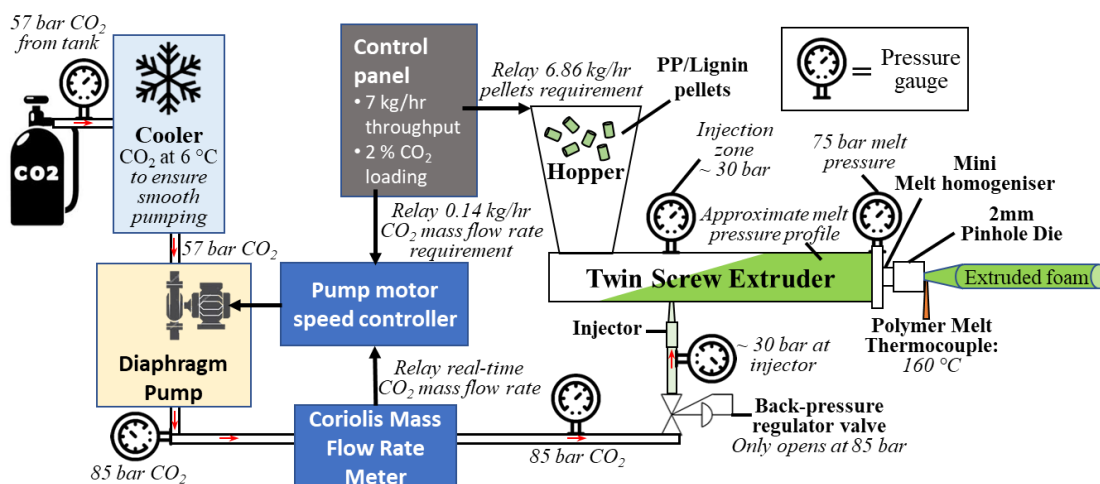


Figure S1. The setup of scCO₂ foam extruder.

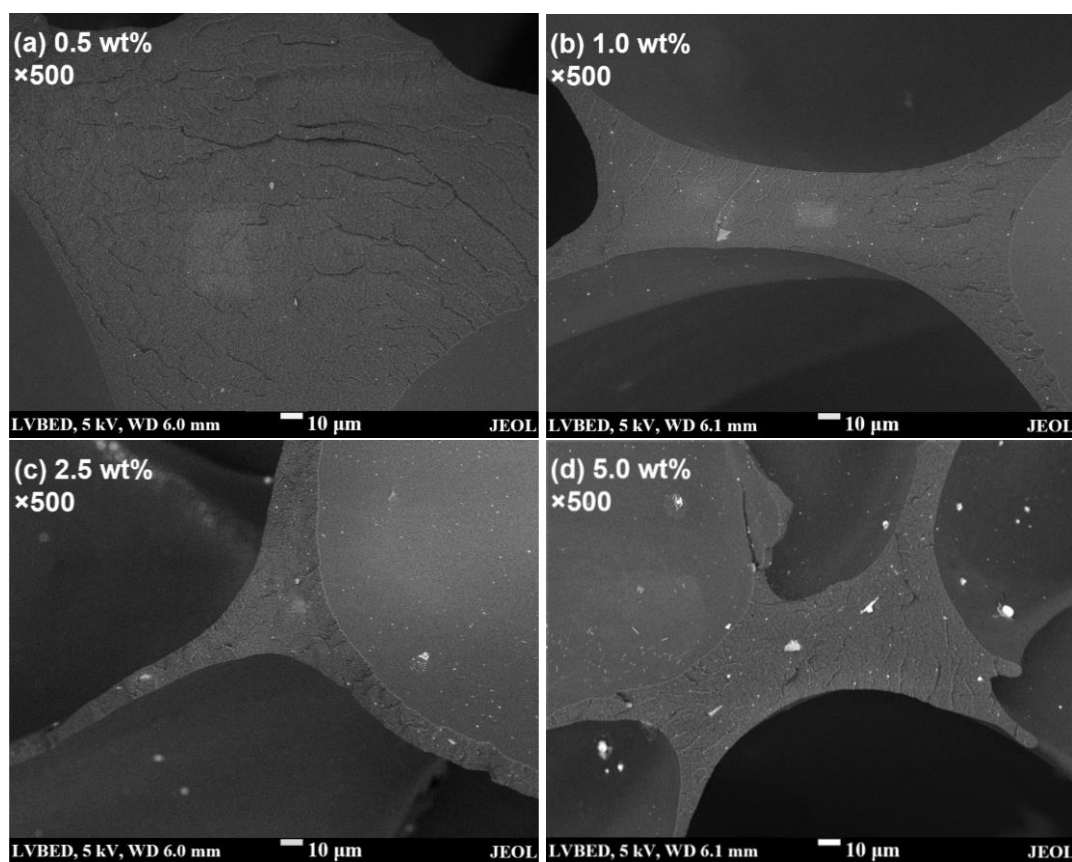


Figure S2. Example of SEM cross-sectional low magnification images of PP/lignin composite foams with (a) 0.5, (b) 1, (c) 2.5, and (d) 5 wt% of lignin used for lignin particle size distribution analysis of diameter $\geq 1 \mu\text{m}$.

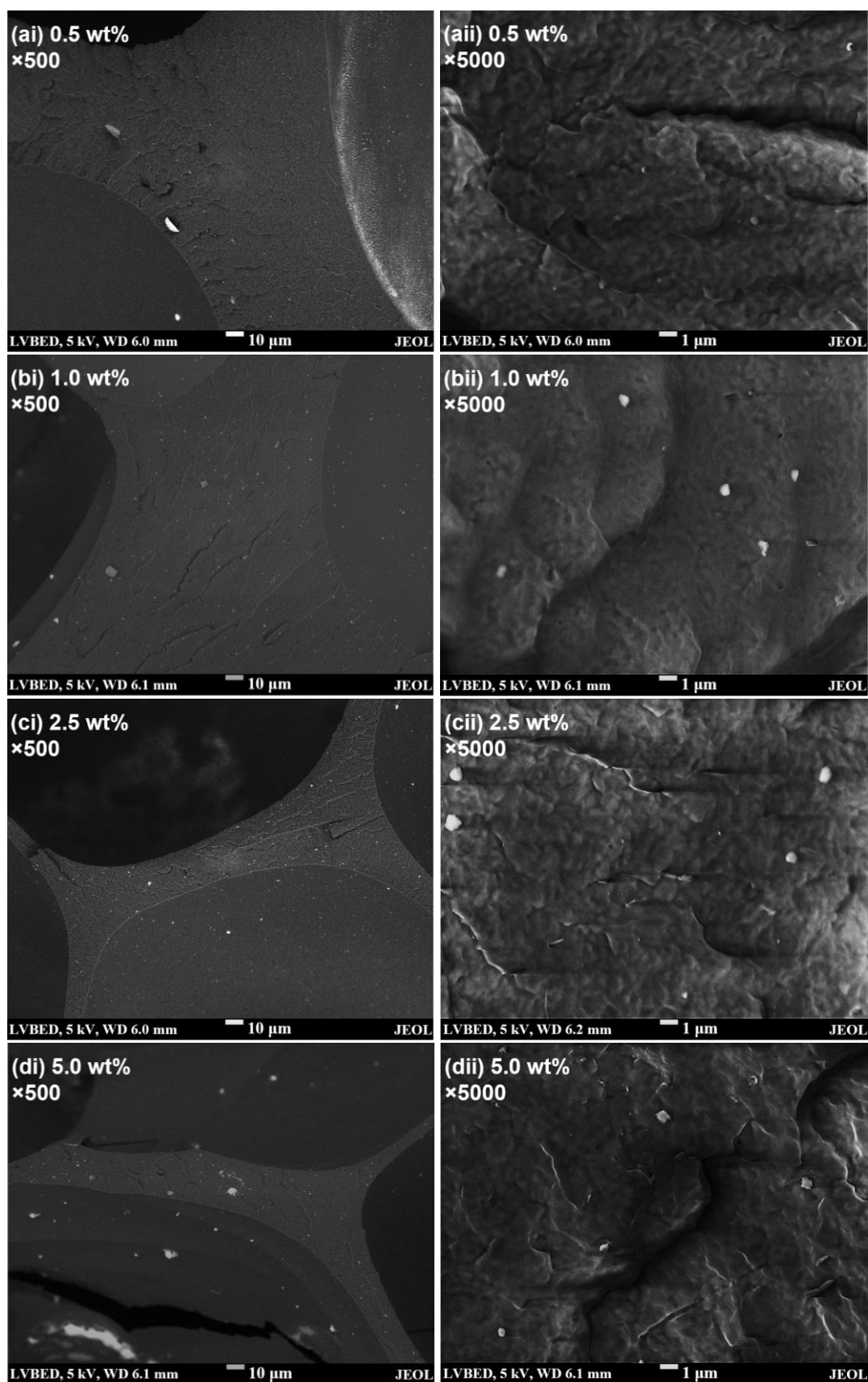


Figure S3. Further examples of SEM cross-sectional images of PP/lignin composite foam at (a) 0.5, (b) 1, (c) 2.5, and (d) 5 wt% used for lignin particle size distribution analysis of diameter (i) $\geq 1 \mu\text{m}$ and (ii) $< 1 \mu\text{m}$.

Table S2. Crystallinity % and melting temperature of PP and PP/lignin foams.

Lignin loading (%)	0.0	0.5	1.0	2.5	5.0
Crystallinity (%)	39.8	40.1	38.8	40.4	39.6
Melting Temperature (°C)	159.1	159.0	159.1	158.7	158.5