Quantitative Study on Removal of SU-8 Photoresist Patterns by Supercritical CO_2 Emulsion

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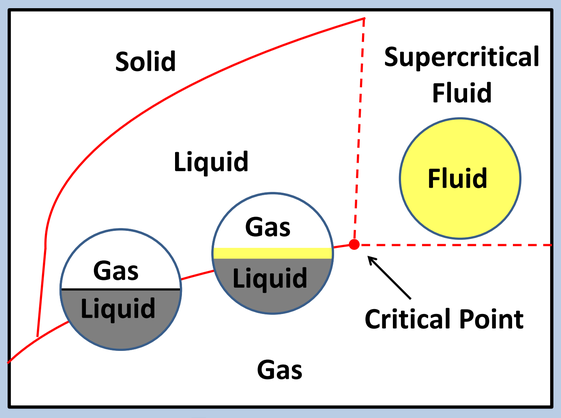
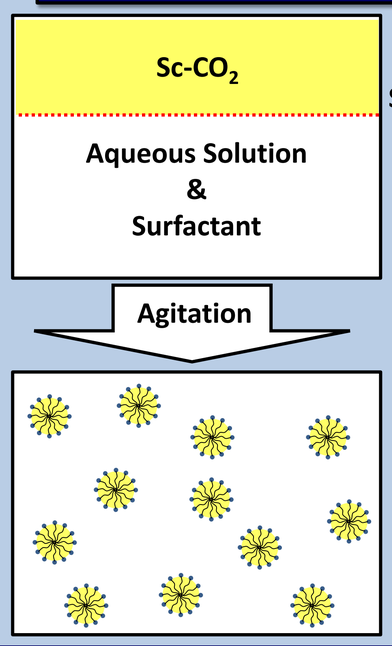
Background

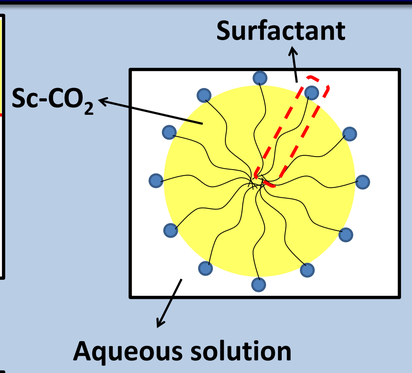
Supercritical State



- **Adjustable physical** and **transport** properties by control of **pressure** or **temperature**
- **Low density** and **viscosity**
- Extremely low **surface tension**

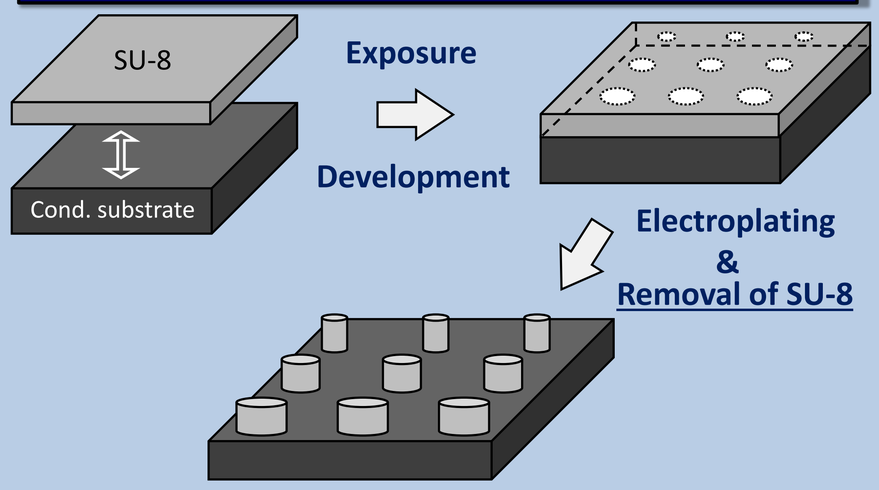
Supercritical Carbon Dioxide Emulsion (SCE)





- High solubility of **organic** and **non-polar** substances
- CO_2 solvent is **cheap** and **green**

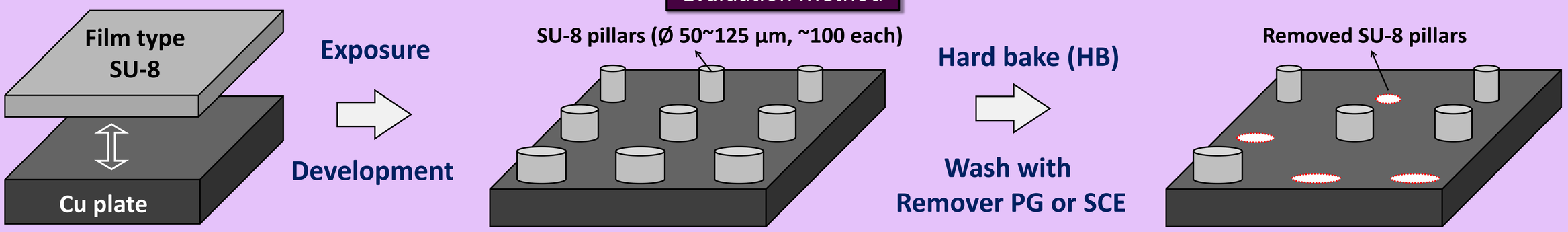
Fabrication of Micro-Structures using SU-8 patterns



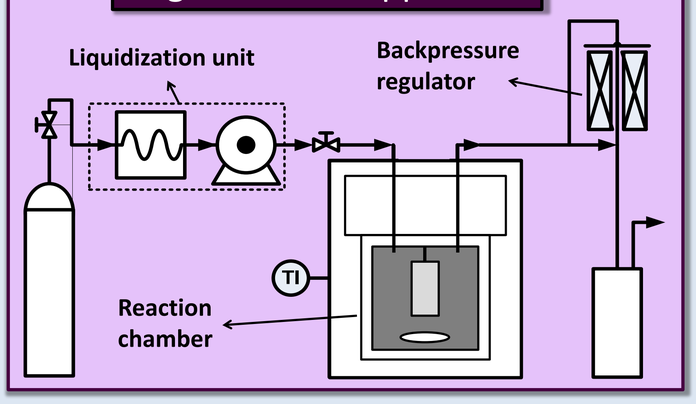
- **Removal of SU-8** has always been a challenge
  - Poor adhesion: delamination in the electrolyte
  - Strong adhesion: difficult to completely remove

Experimental Section

Evaluation Method



High Pressure Apparatus



Materials

- **Film type SU-8**
  - Kayaku MicroChem, 50 µm thickness
- **Substrate**
  - 1X2 cm^2 Cu plate
- **Remover PG (RPG)**
  - Kayaku MicroChem,
- **Surfactant**
  - polyoxyethylene lauryl ether ($C_{12}H_{25}(OCH_2CH_2)_{15}OH$)

Exposure & Development

- **Exposure Energy:** 500 mJ/cm^2
- **Development temp.:** 25 ℃
- **Development time:** 3 min

Wash by Remover PG

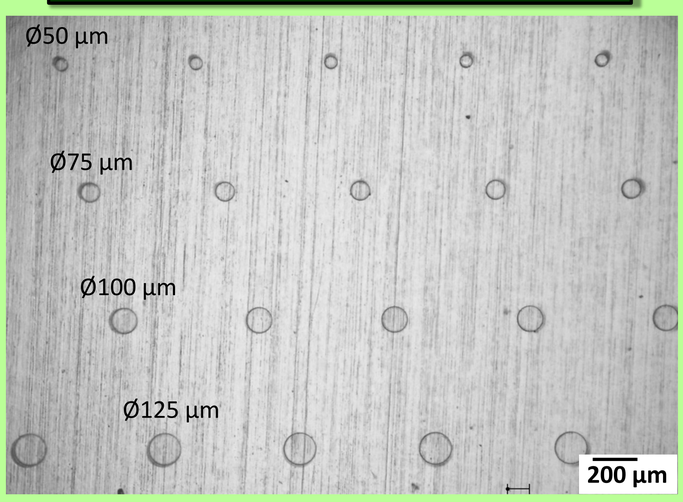
- **Temperature:** 70 ℃
- **Time:** 10 min

Wash by SCE

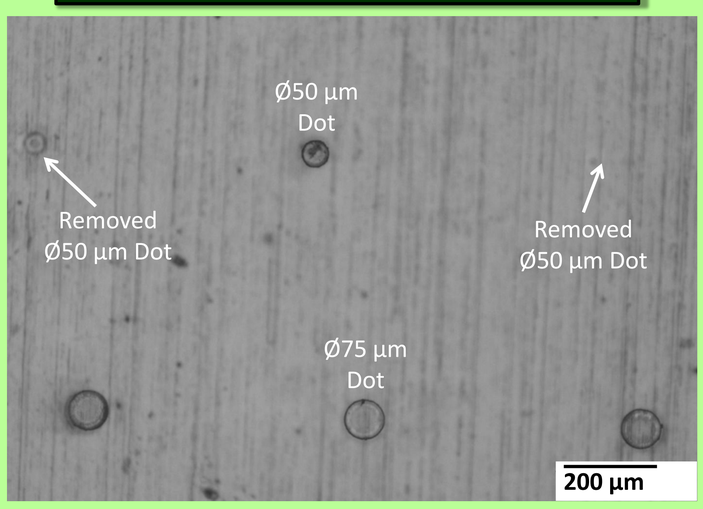
- **Temperature:** 50 ℃
- **Pressure:** 15 MPa
- **CO_2 vol%:** 20 vol%
- **Surfactant vol%:** 0.2 vol%
- **H_2O vol%:** 80 vol%
- **Time:** 10 min

Results and Discussion

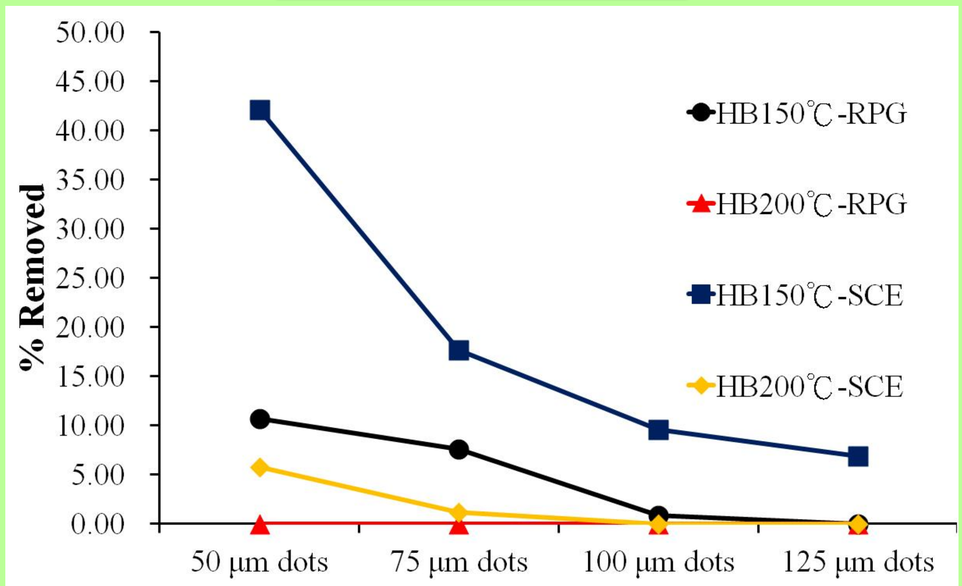
SU-8 dots prepared, before washing



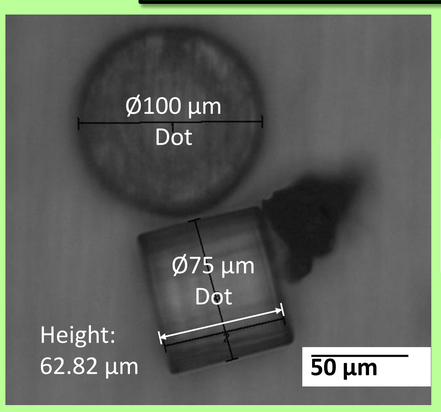
SU-8 dots, after washing with SCE



% of SU-8 dots removed



SU-8 dots being removed



Delaminated SU-8 dots were still intact

% of SU-8 dots removed

	Ø (µm)	% Removed by RPG	% Removed by SCE
No hard-baking	50	100	100
	75	100	100
	100	100	100
	125	100	100
Hard-baked at 100 ℃ for 10 min	50	100	100
	75	100	100
	100	100	100
	125	100	100
Hard-baked at 150 ℃ for 10 min	50	10.71	42.11
	75	7.56	17.65
	100	0.88	9.62
	125	0	6.90
Hard-baked at 200 ℃ for 10 min	50	0	5.75
	75	0	1.15
	100	0	0
	125	0	0

Conclusions

- **Supercritical CO_2 emulsion is effective in removal of SU-8 photoresist patterns and works better than commercially available Remover PG.**
- **Supercritical CO_2 emulsion could even remove some of the hard baked (150 and 200 ℃ for 10 min) SU-8 dots.**

Acknowledgement

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Reference

- Chang et al., Microelec. Eng. 88 (2011) 2225.
- Ishiyama et al., Microelec. Eng. 88 (2011) 2272.
- Dentinger et al., Microelec. Eng. 61-62 (2002) 993.