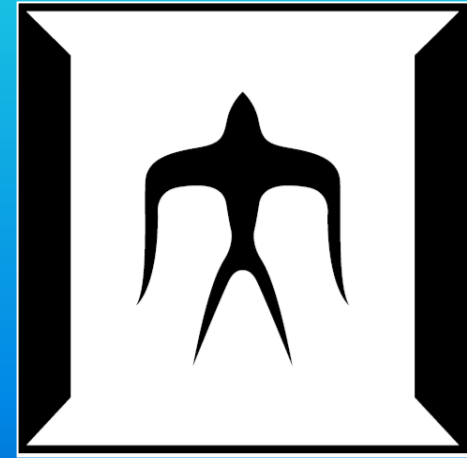


# Metallization on Textile by Electroless Plating with Pd or Pt Catalyzation in Supercritical Carbon Dioxide for Sensing Wearable Device



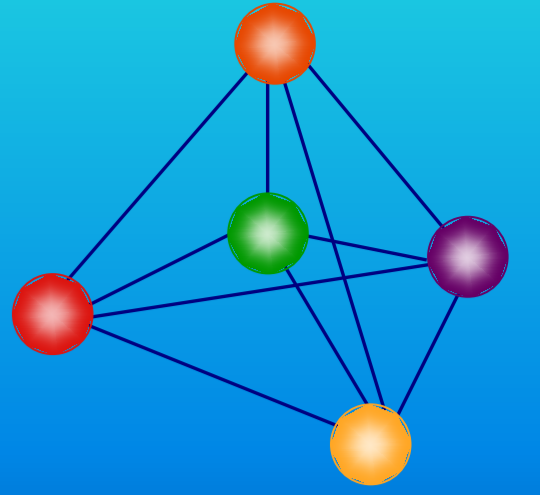
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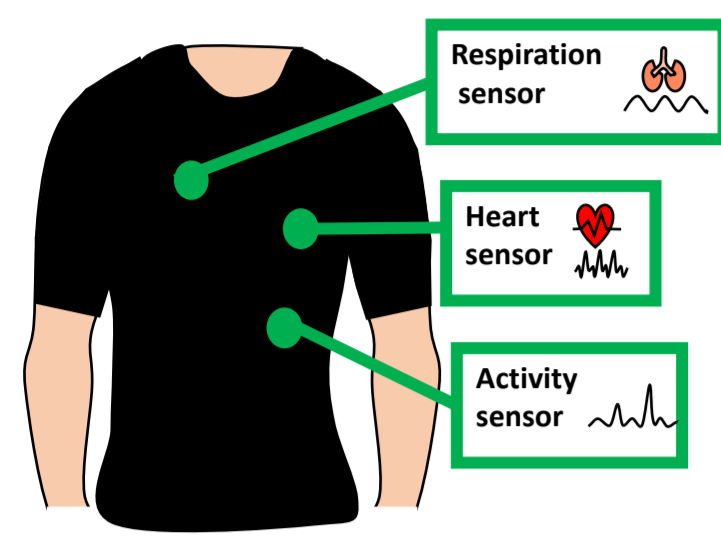
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## Introduction

### Wearable devices applied in various fields



Applications of wearable sensors  
 ✓ Underwear  
 → Detect alcohol level  
 ✓ Sportswear  
 → Track motion

### One of the challenging points in wearable devices

→ **Deposition of metallic materials on the textile**

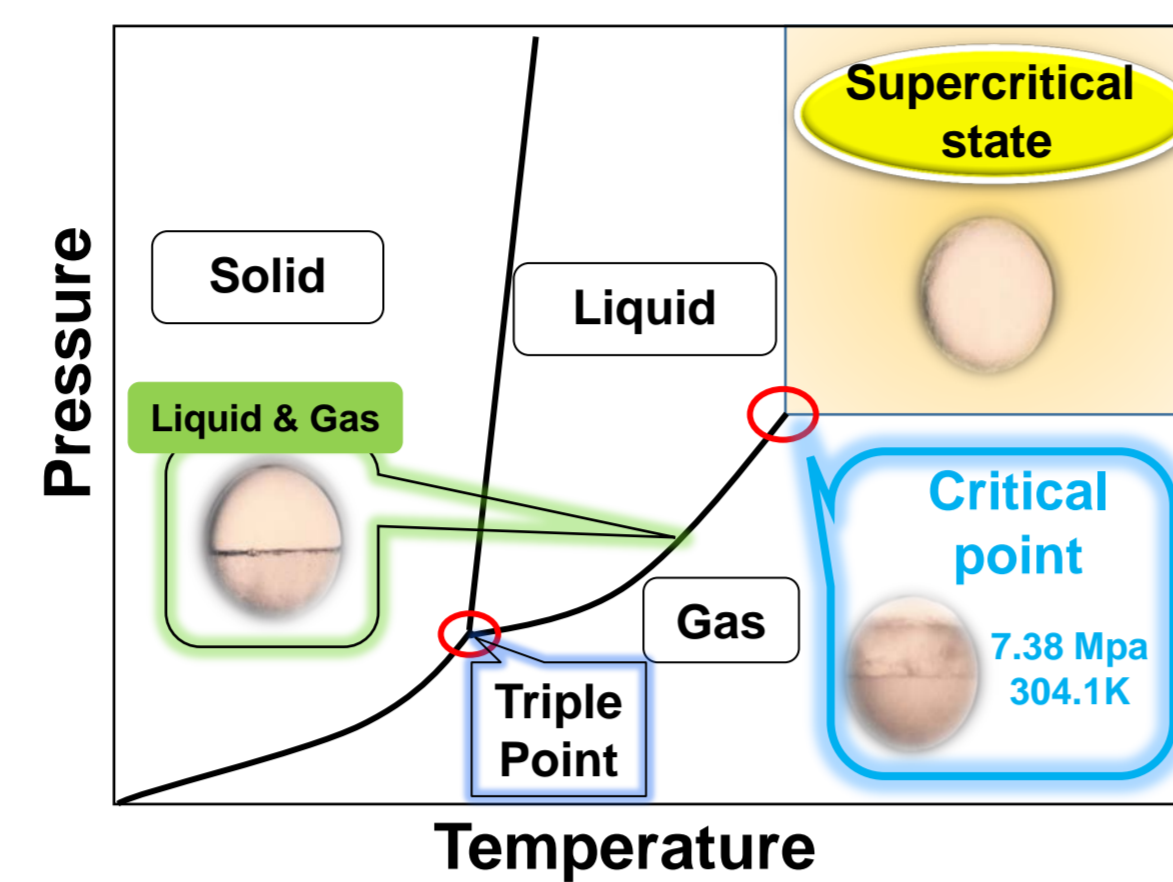
Electroless plating method can be applied in metallization of the textile

Especially when applied on the human body, it is of great importance that the sensing system is biocompatible

→ **Platinum has excellent biocompatibility.**

WATAHA et al., Journal of Oral Rehabilitation 1996 23; 309-320

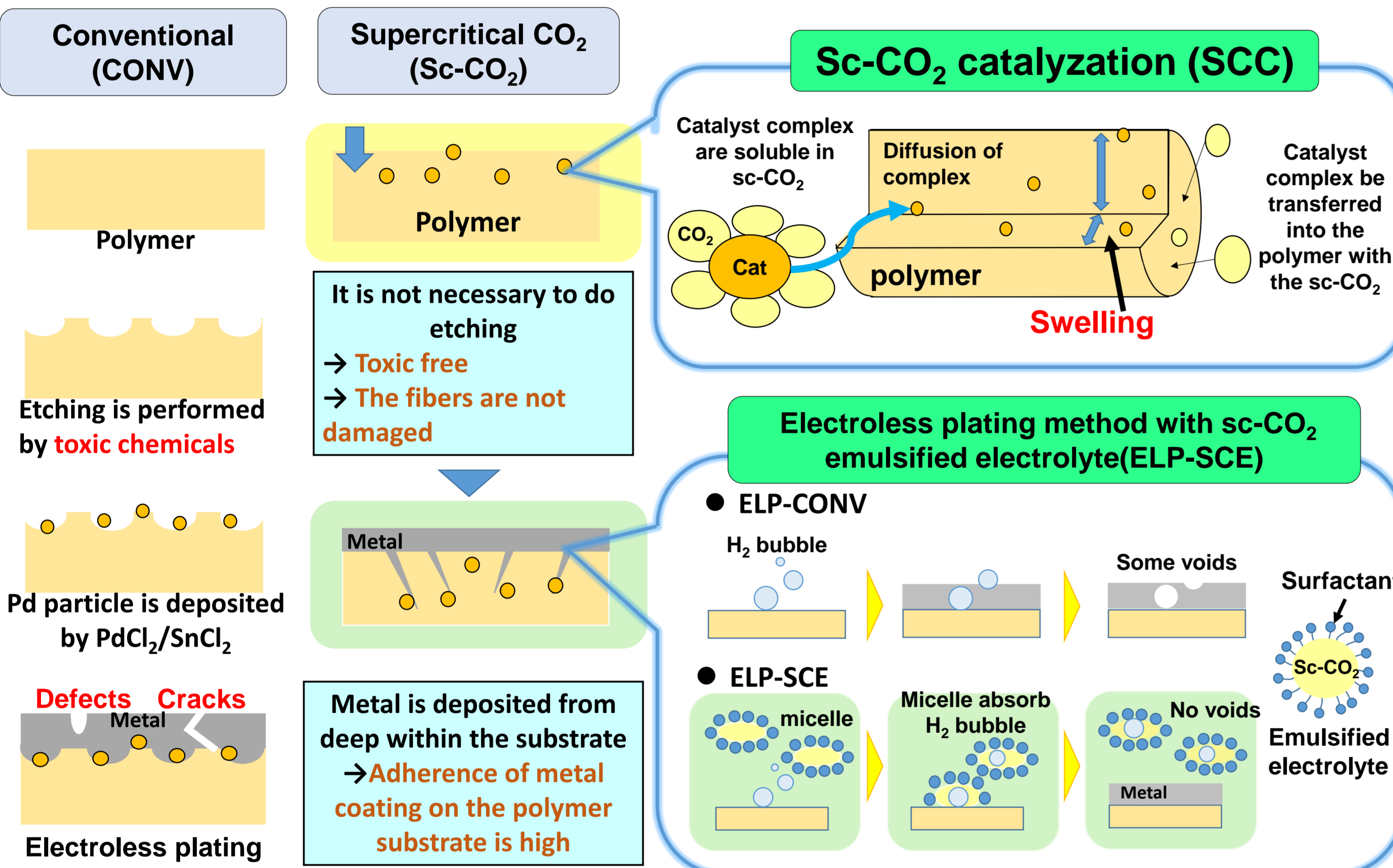
### Supercritical carbon dioxide (Sc-CO<sub>2</sub>)



Supercritical CO<sub>2</sub>  
 • High diffusivity  
 • Low viscosity

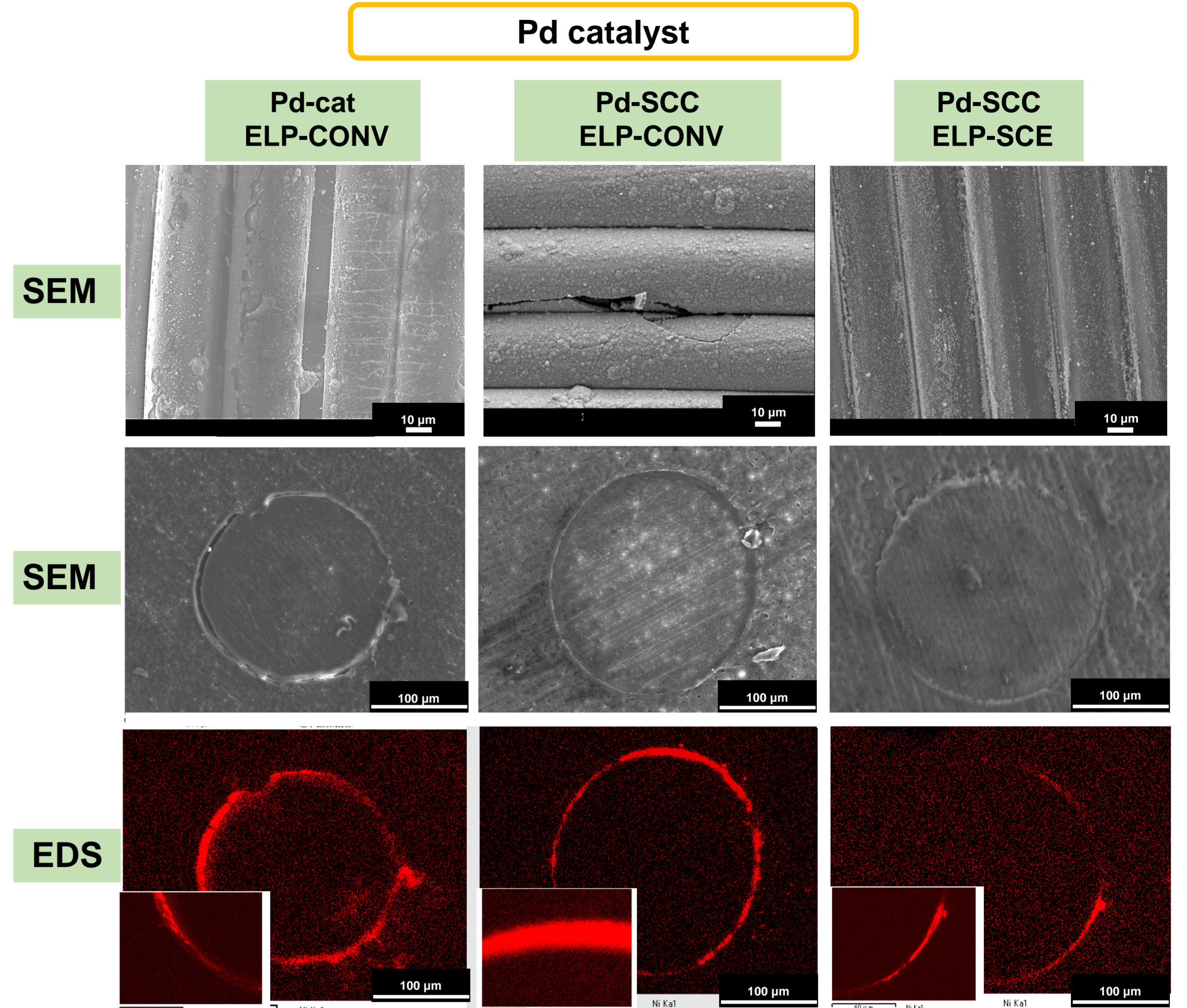
It can improve transfer of materials into very fine space

### Process flow for electroless plating



## Results and Discussion

### Surface morphology and cross-sectional of Ni-P

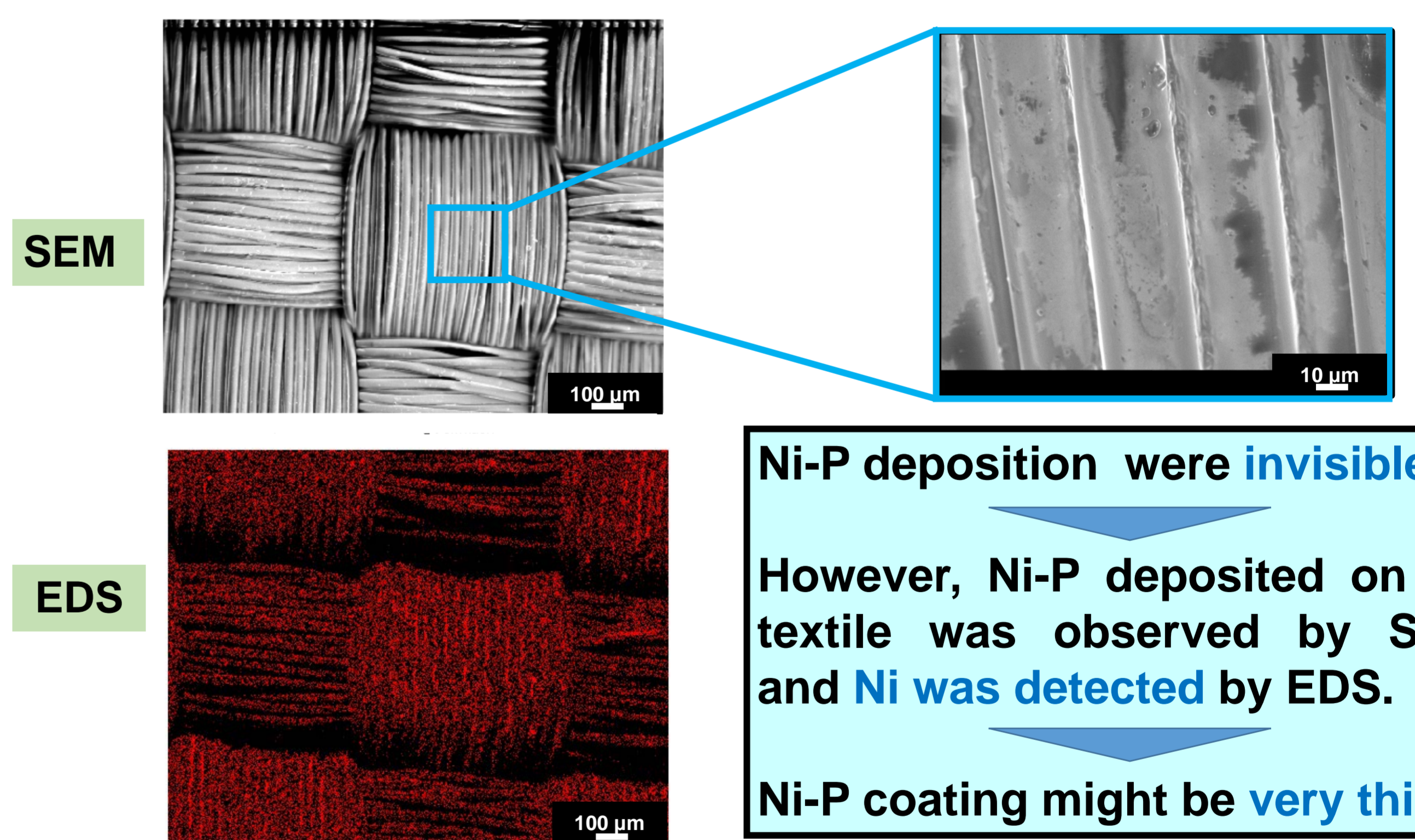


Pd-cat+CONV : there were some pin-holes and cracks.

Pd-SCC+ELP-CONV : no pin-hole and showed Ni coating on the surface of each fiber. But, there were a few peeled-off parts.

Pd-SCC+ELP-SCE : no pin-hole with very smooth structure and showed Ni coating on the surface of each fiber.

### Pt catalyst



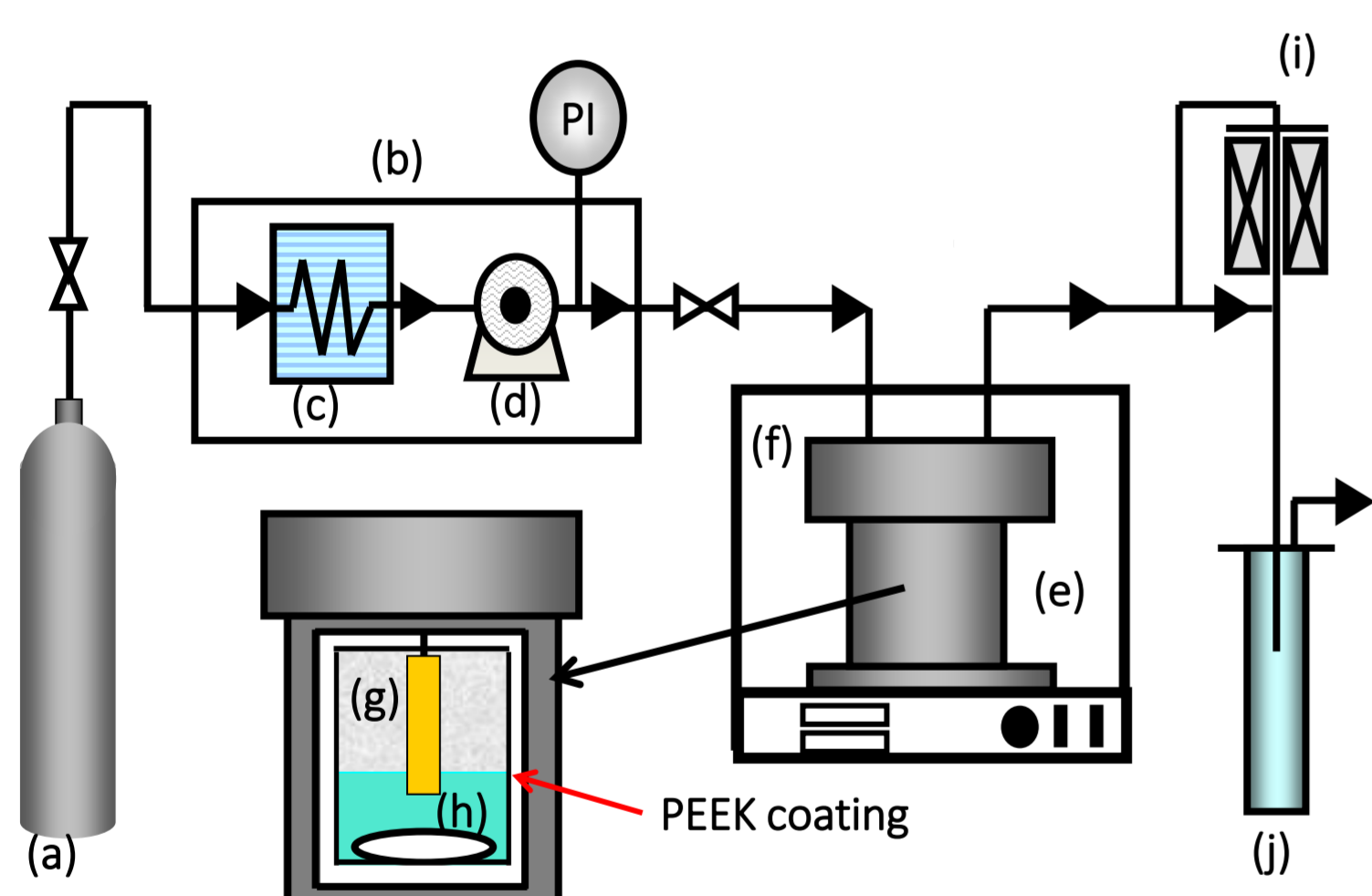
Ni-P deposition were invisible.

However, Ni-P deposited on the textile was observed by SEM, and Ni was detected by EDS.

Ni-P coating might be very thin.

## Experimental

### High pressure apparatus



Woo et al., Surf. Coat. Tech., 203 (2009) 1971-1978

- CO<sub>2</sub> gas tank
- CO<sub>2</sub> liquidization unit
- Liquidization unit
- High pressure pump
- Thermal bath
- Reaction-cell (PEEK-lined SUS316L)
- Substrate
- Cross stirrer
- Back pressure regulator
- Trap

### Materials

Plating	
Ni-P bath	
NiCl <sub>2</sub>	9 wt.%
NaPO <sub>2</sub> H <sub>2</sub>	12 wt.%
Complexing agent	12 wt.%
Ion-exchanged water	67 wt.%
CO <sub>2</sub>	20 vol.%
C <sub>12</sub> H <sub>25</sub> (OCH <sub>2</sub> CH <sub>2</sub> ) <sub>15</sub> OH (Surfactant : ELP-SCE)	0.2 vol.%
Pt bath	
MATEX PLATINUM ELPt-2	51 vol.%
NH <sub>3</sub>	5 vol.%
Ion-exchanged water	44 vol.%
Substrate	Nylon 6,6 textile
Conditions	
Pressure	Atmosphere (CONV) 15 Mpa (ELP-SCE)
Temperature	353 K
Plating time	Ni-P: 1, 20 min Pt: 3.5 h (CONV) 60 min (ELP-SCE)

### Pretreatment

Pd catalyzation (Pd-cat)	
PdCl <sub>2</sub>	100 mg/L
SnCl <sub>2</sub>	10 mg/L
HCl	87.5 g/L
Pretreatment time	10 s
Pd-SCC or Pt-SCC	
Pd bis-acetylacetonate	3.2823 × 10 <sup>-4</sup> mol
Pt bis-acetylacetonate	5.085 × 10 <sup>-5</sup> mol
Pretreatment time	120 min
Temperature	353 K
Pressure	15 MPa

## Conclusions

- Uniform Ni coating on surface of each fiber was obtained when both the Pd-SCC and ELP-SCE were applied
- Ni-P deposited on the textile by ELP-SCE after Pt-SCC.
- Pt coating on surface of each Nylon 6,6 fiber was obtained by ELP-CONV after Pt-SCC.

## Acknowledgement

This work has been supported by The Grant-in-Aid for Scientific Research (B) (JSPS KAKENHI Grant Number 26282013) and CREST Project operated by the Japan Science and Technology Agency (JST).