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2010 ISOE Asia ALARA Symposium

# Development of Hi-F Coat for Carbon Steel Piping

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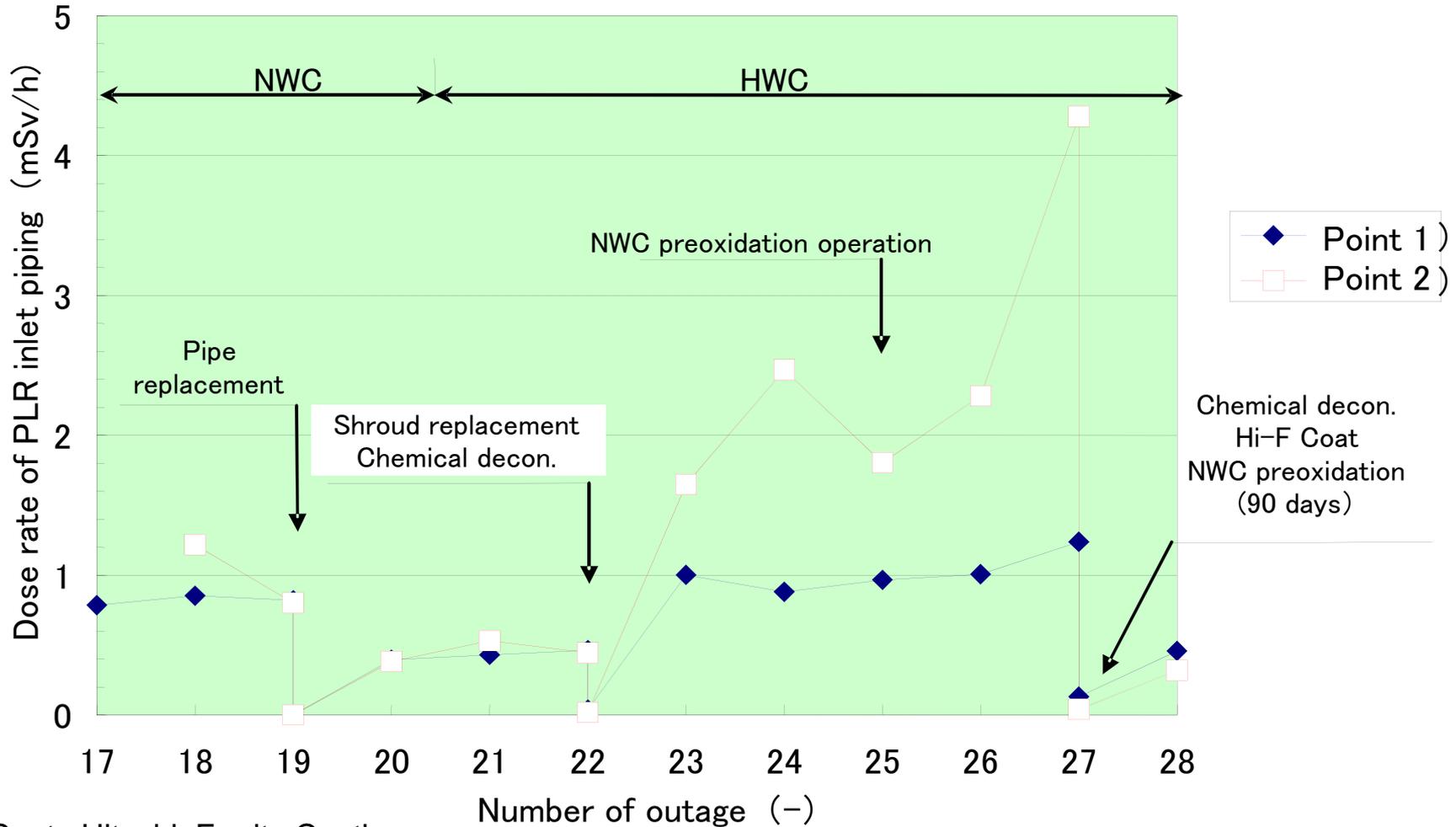
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# 1. Application result of Hi-F Coat for SS

Low recontamination by Hi-F Coat was confirmed for Stainless Steel.



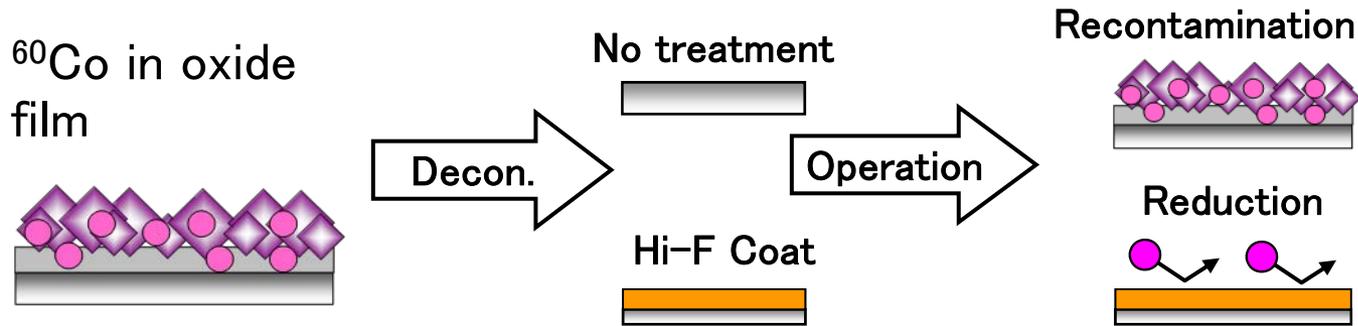
Hi-F Coat ; Hitachi Ferrite Coating  
NWC ; Normal water chemistry  
HWC ; Hydrogen water chemistry

M. Nagase, et al.,2009 ISOE Asian ALARA Symposium

## 2. Enlargement of Hi-F Coat application area

CUW piping is one of the biggest sources of radiation exposure.

### 【Countermeasure to reduce recontamination】



Principal: Reduction of  $^{60}\text{Co}$  deposition by reducing base metal corrosion

### 【System and its countermeasure】

System	Material	Problem	Countermeasure
RRS※1	SS※3	▪ RI deposition	Hi-F
RWCU※2	SS CS※4	▪ RI deposition ▪ Corrosion	No method after chemical decon.

※1 ; Reactor recirculation system

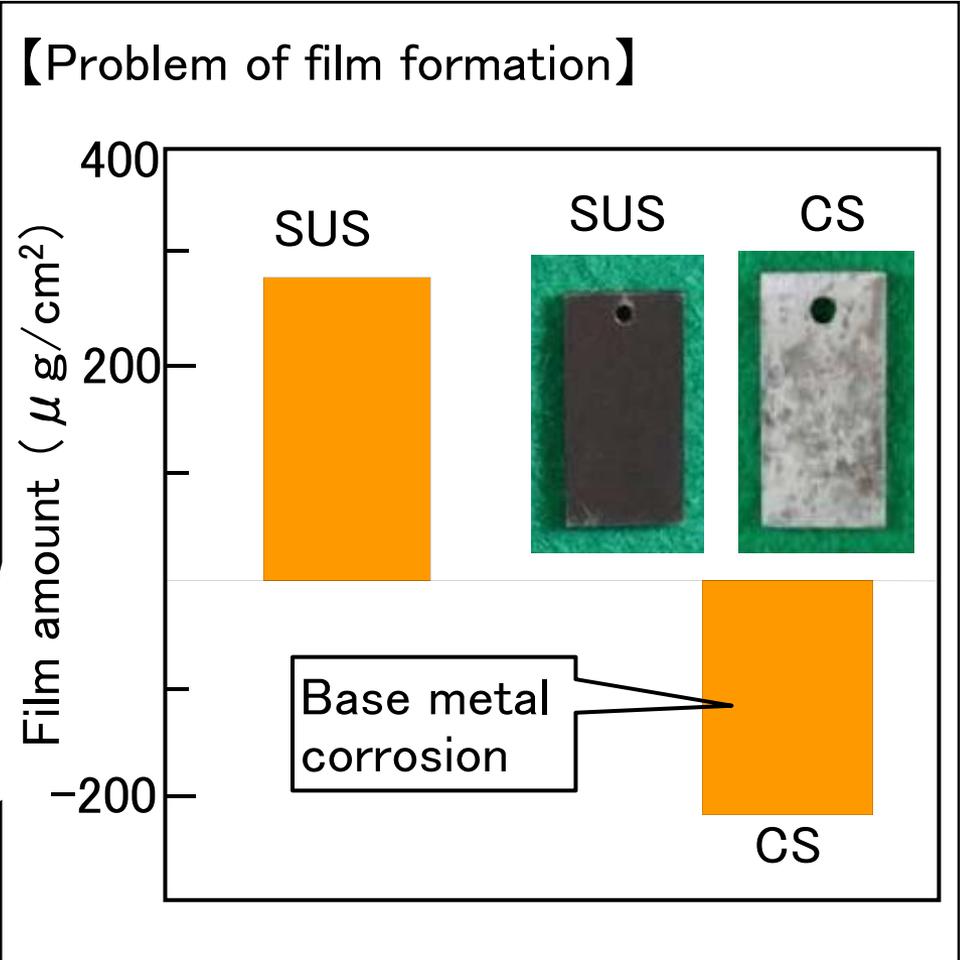
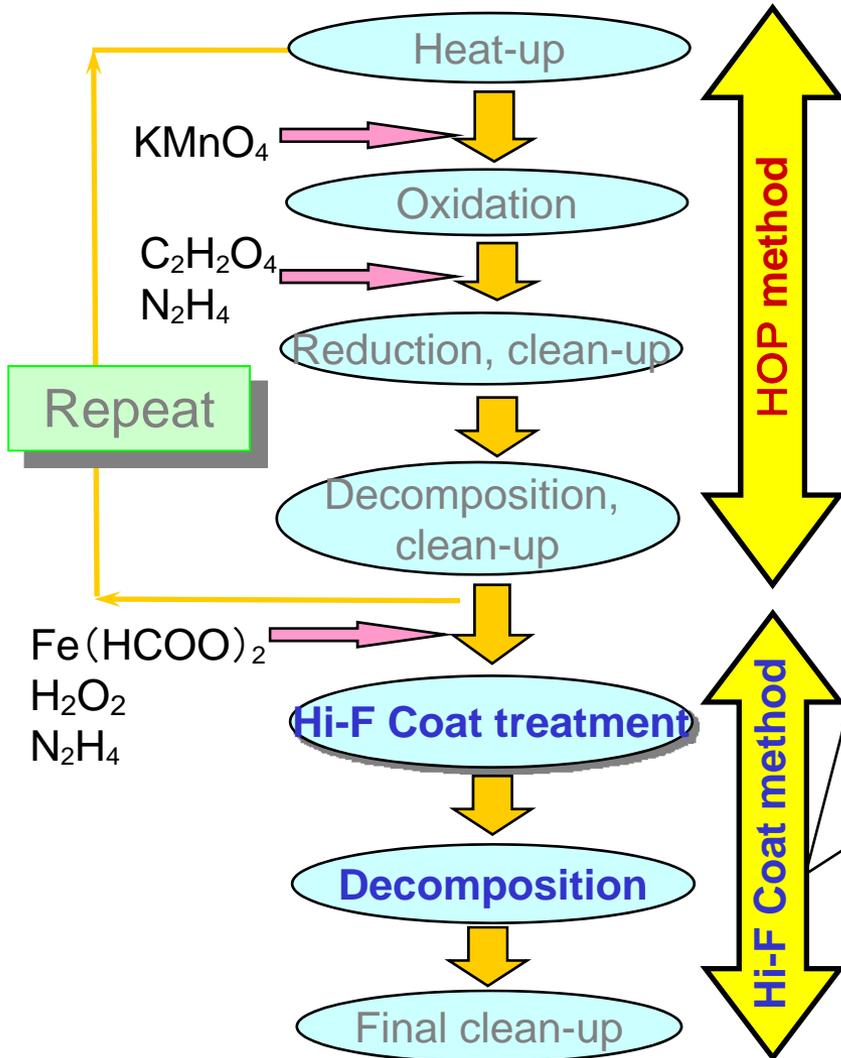
※2 ; Reactor water clean up

※3 ; Stainless steel ※4 ; Carbon steel

# 3. Problem of Hi-F Coat for CS

Hi-F Coat procedure for SS is not applicable for CS.

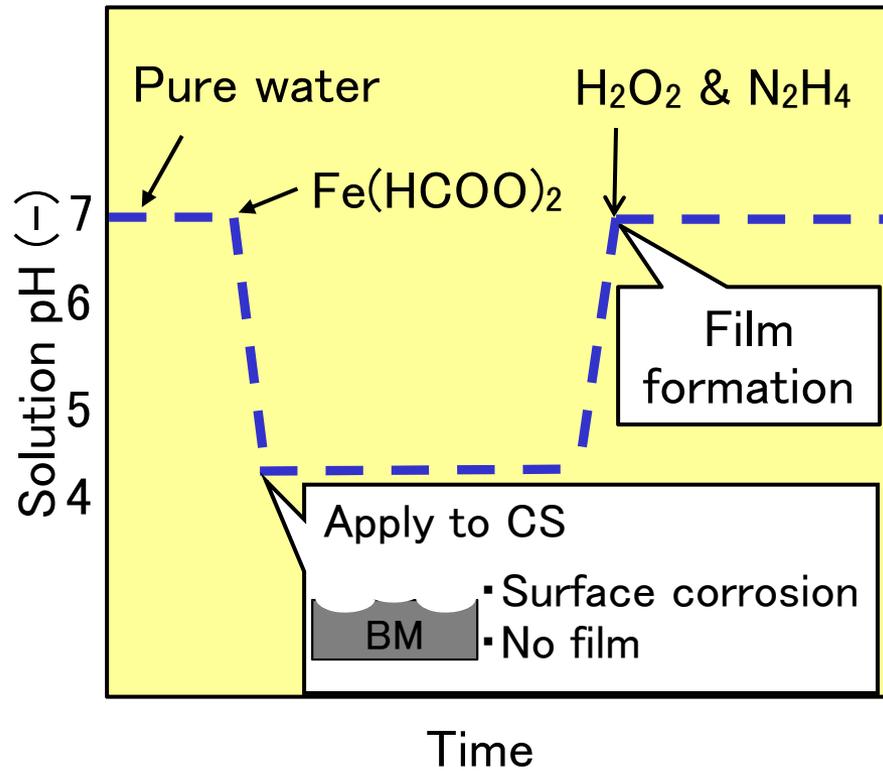
## 【Procedure of Hi-F Coat】



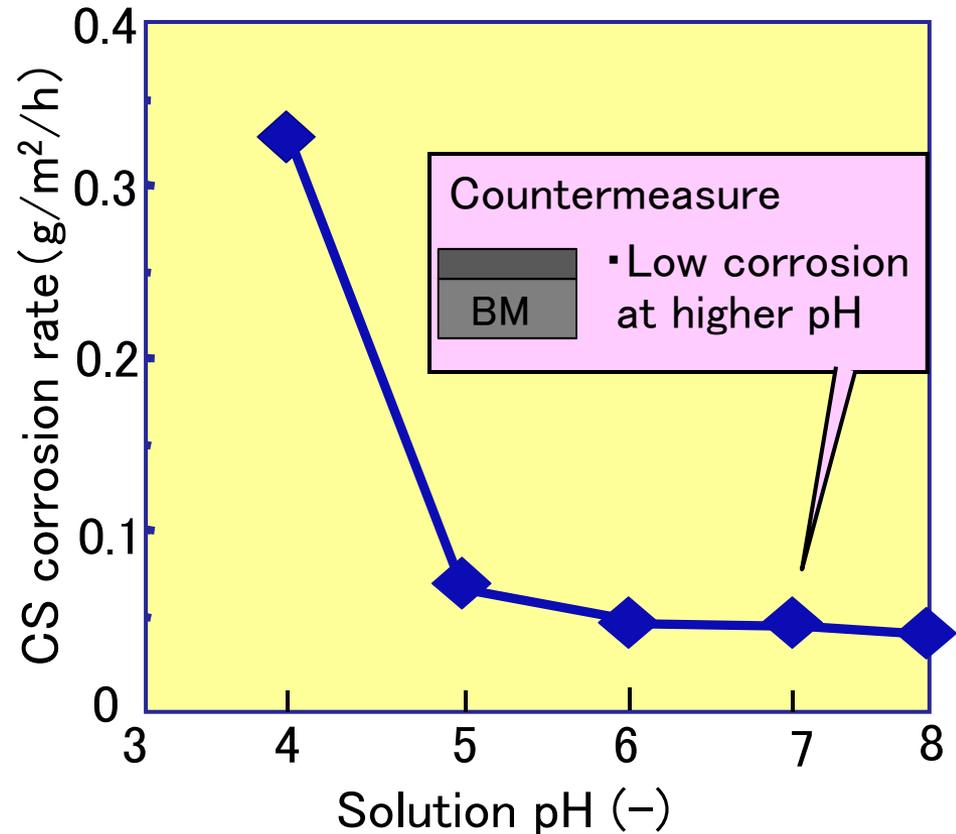
# 4. Idea for Hi-F Coat procedure for CS

Higher pH is a key parameter to reduce CS corrosion.

【Procedure of film formation for SS】



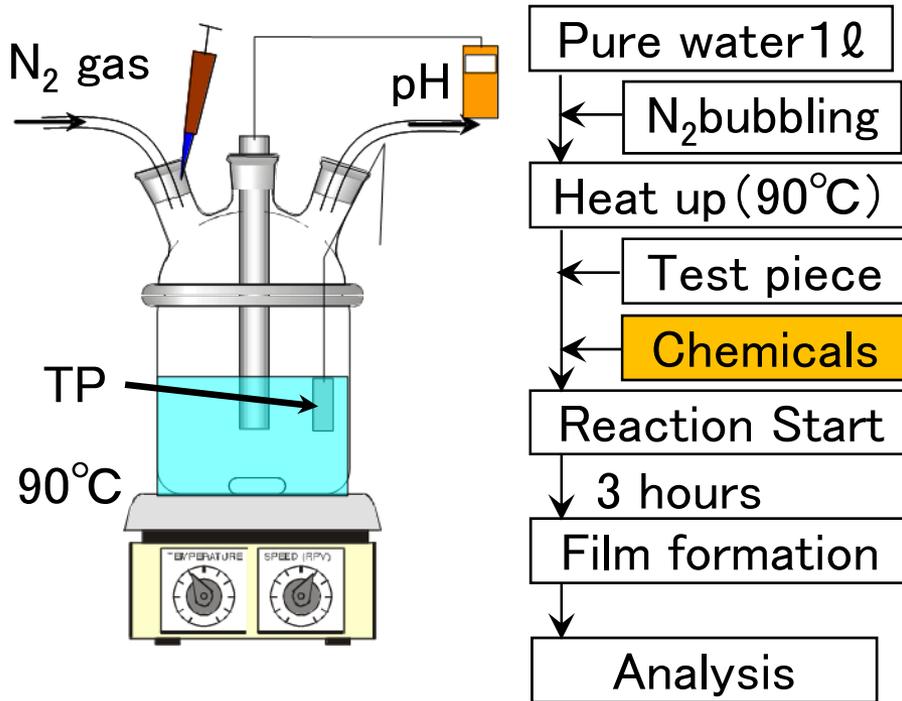
【Idea for film formation】



BM ; Base Metal

# 5. Conditions of film formation

## 【Experimental apparatus】

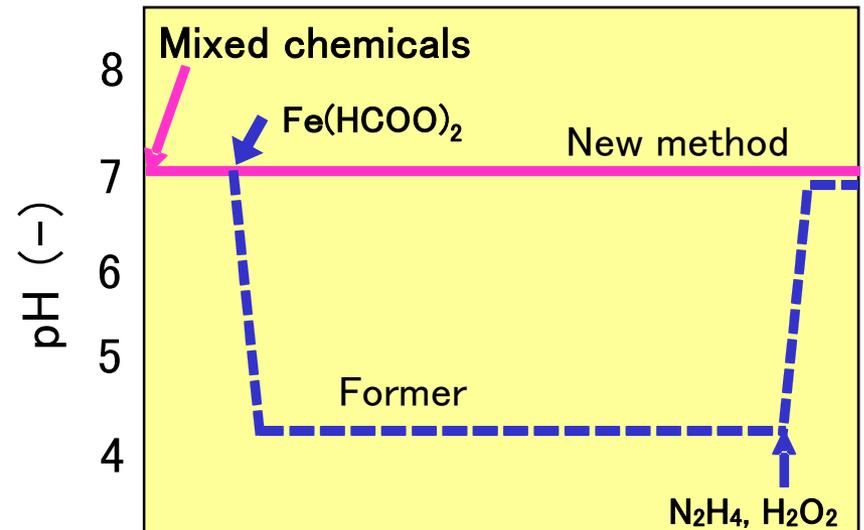


## Analysis method

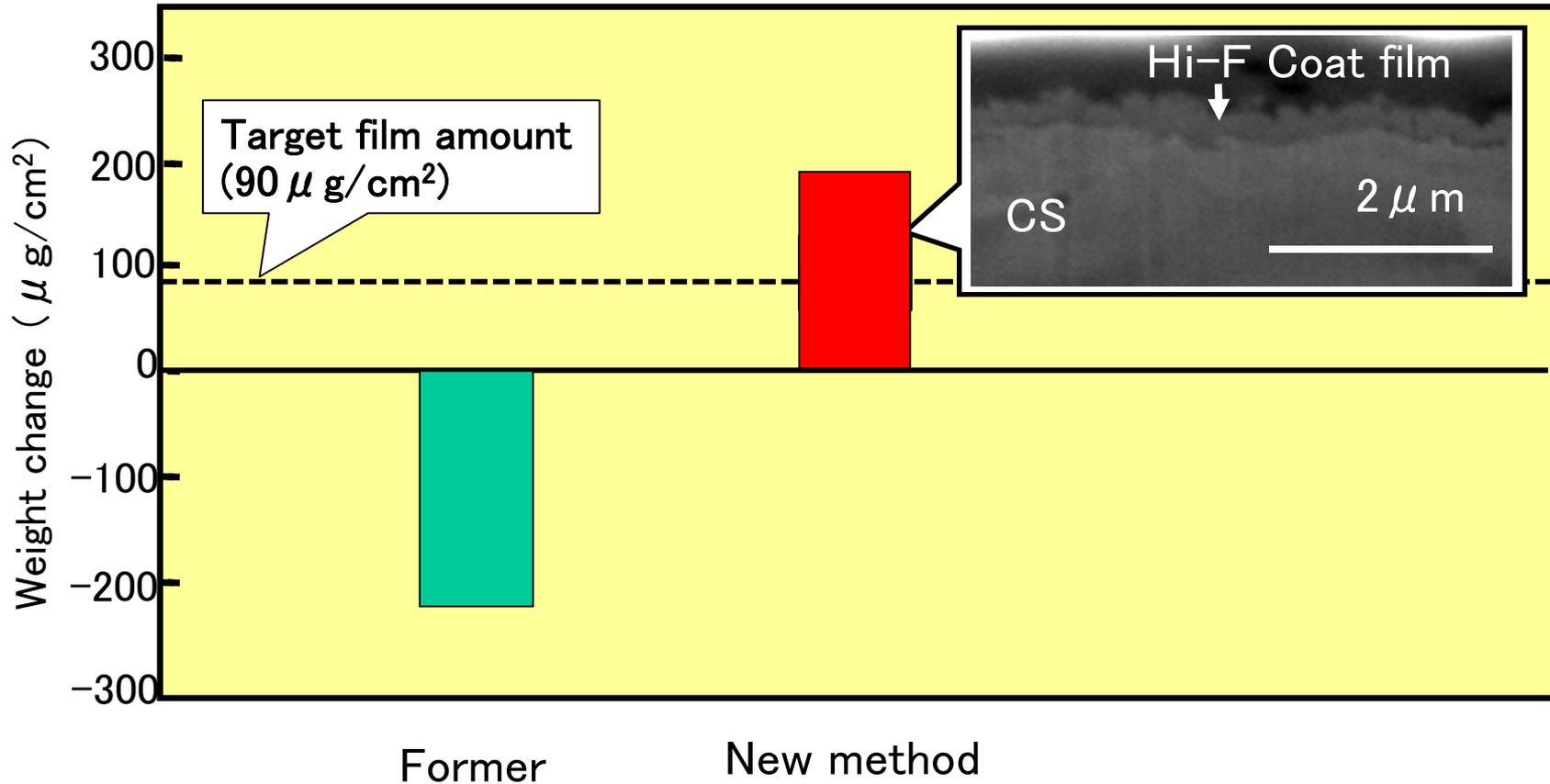
- Crystal structure . . . . X ray deflection
- Binding status . . . . XPS
- Film structure . . . . SEM
- Film composition . . . . Raman spectrum
- . . . . Auger spectrum

## 【Injection order and pH】

	Chemical conc. (ppm)		
	1	2	3
Former	Fe(HCOO) <sub>2</sub> (300)	H <sub>2</sub> O <sub>2</sub> (15)	N <sub>2</sub> H <sub>4</sub> (600)
New method	Mixing all chemicals in advance		

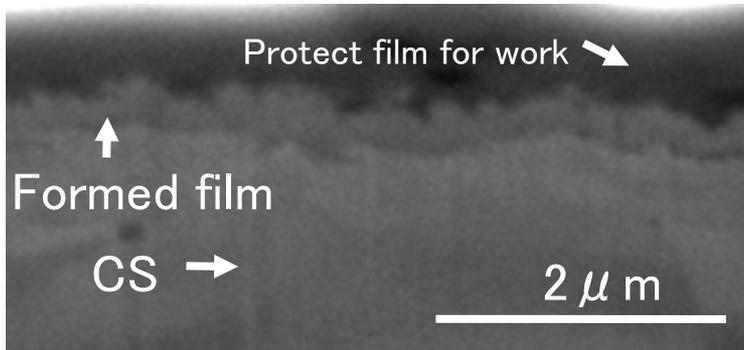


The new method enables to make a enough film amount on CS.

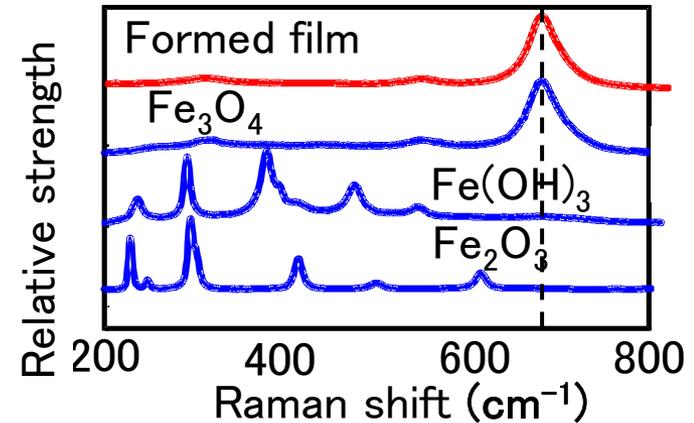


Fine mono layer of polycrystalline  $\text{Fe}_3\text{O}_4$  was identified.

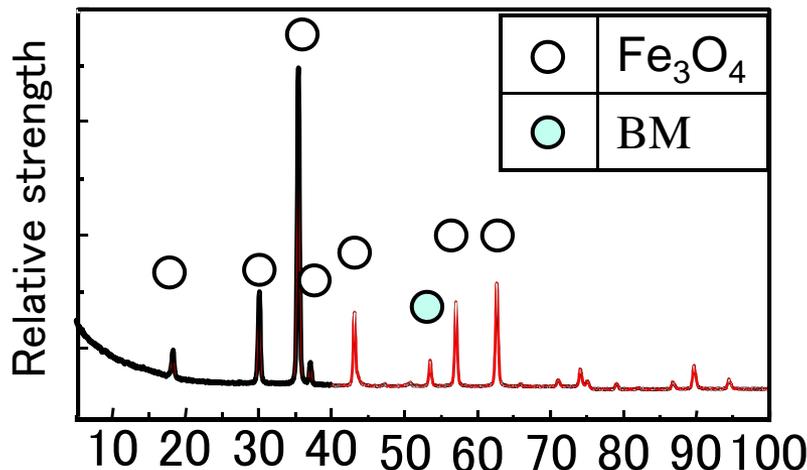
【Cross section】



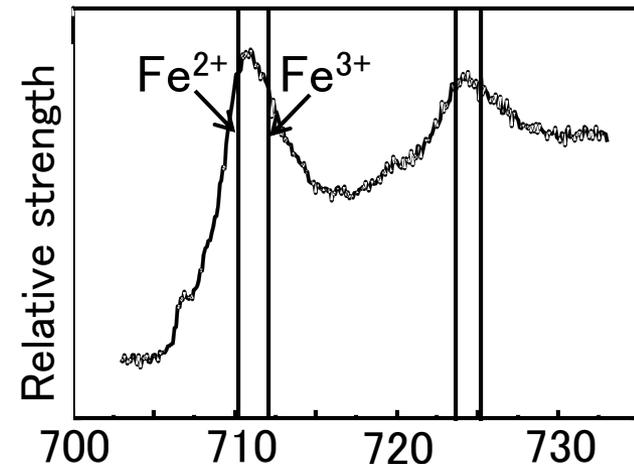
【Film composition】 Identified as  $\text{Fe}_3\text{O}_4$



【Crystal structure】 Polycrystalline  $\text{Fe}_3\text{O}_4$



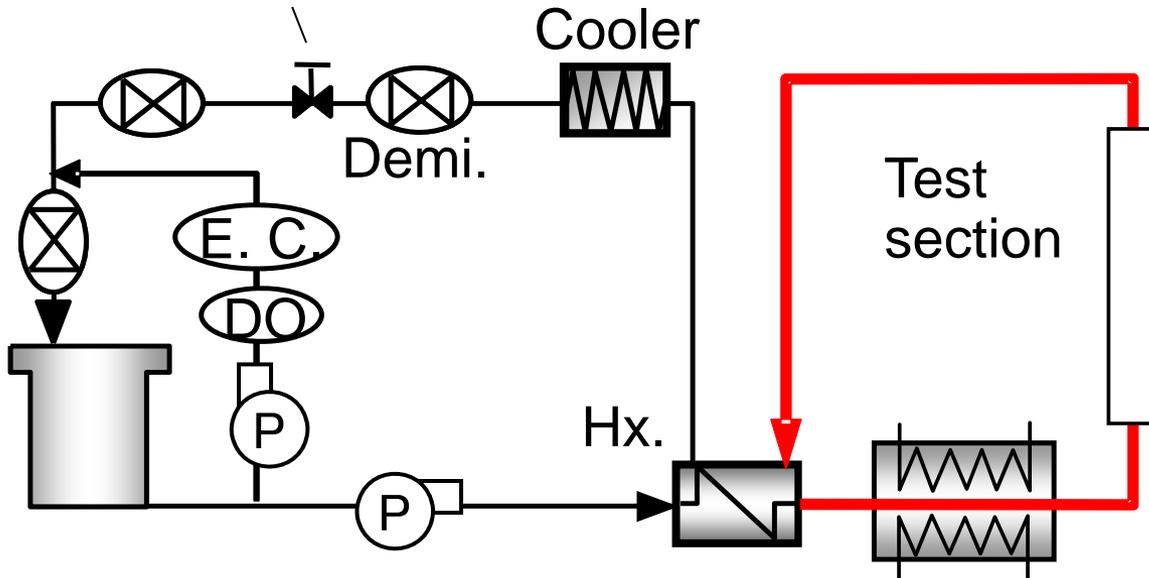
【Binding status】 Existing ratio agrees with  $\text{Fe}_3\text{O}_4$



# 8. Co deposition test conditions

Test was performed under simulated NWC conditions.

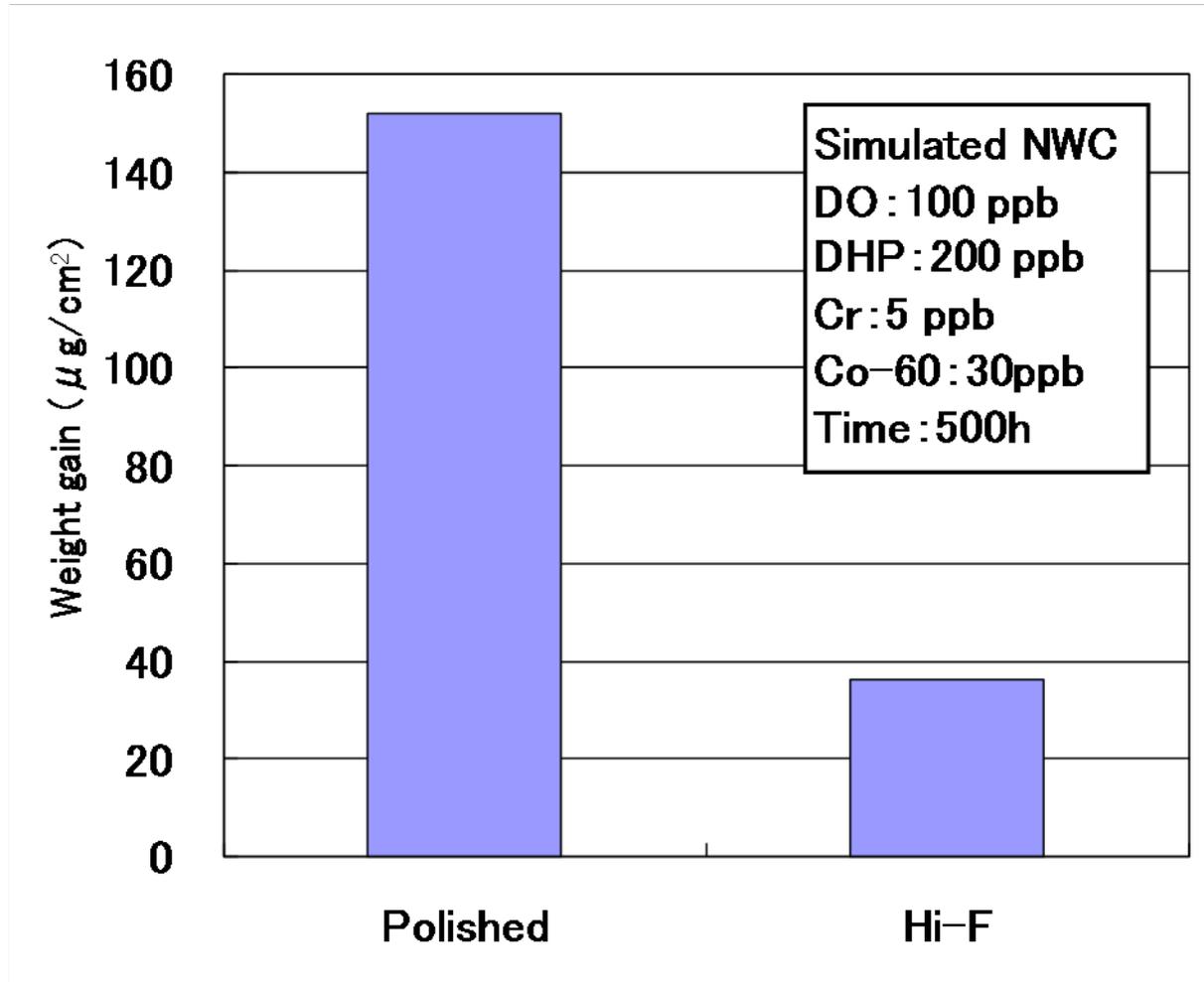
Pressure Control Valve



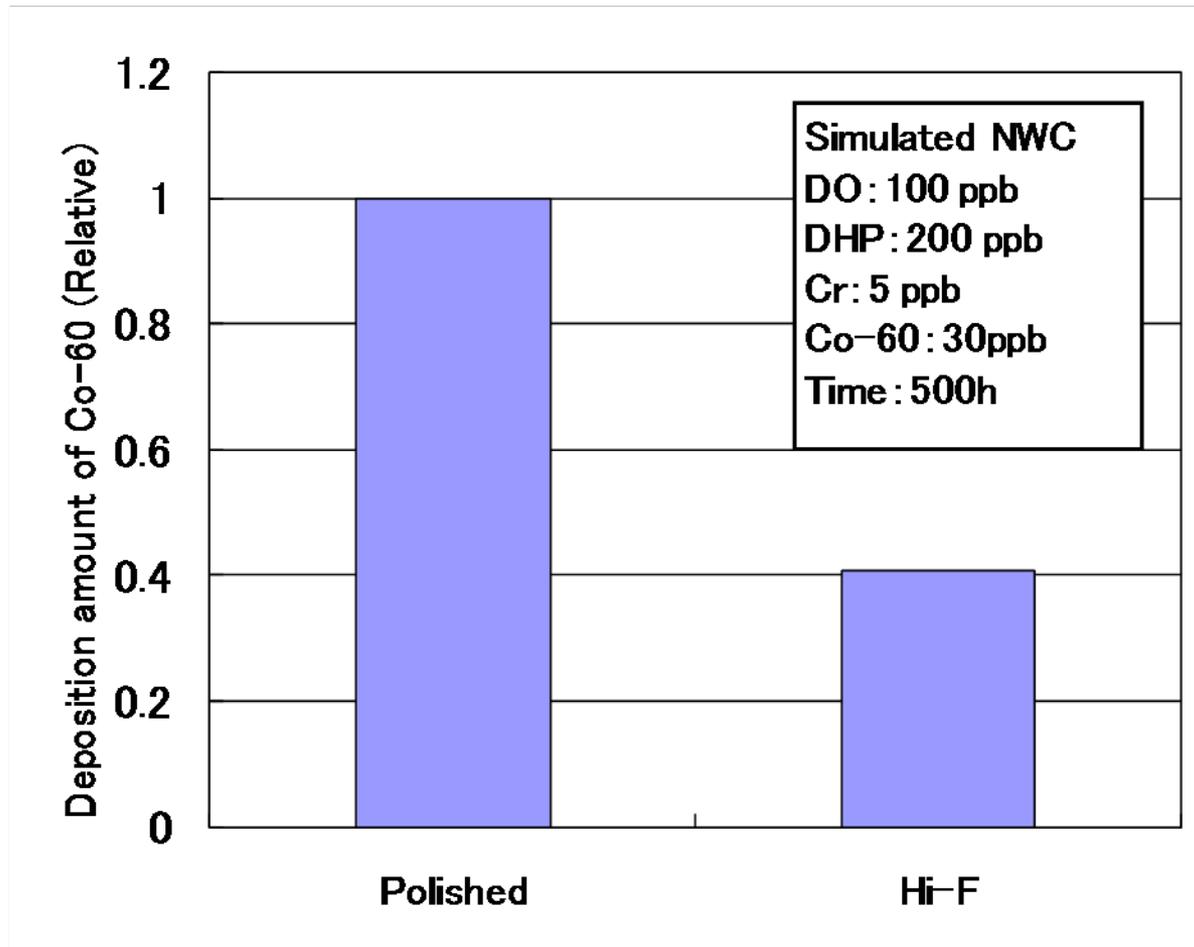
Test conditions

(NWC)	
Temperature	280 °C
Time	500 h
Pressure	7.8 MPa
Concentration (ppb)	
DO	100
DH	10
H <sub>2</sub> O <sub>2</sub>	200
Cr	5
Co-60	30

Weight gain of CS was reduced to about 1/4 under simulated NWC.



Co-60 deposition on CS was reduced to about 40% under simulated NWC.



Film formation method on CS was studied in order to reduce corrosion and Co-60 deposition and its effect was confirmed.

### 【Results】

- Film formation was realized by reducing CS corrosion.
- Target film amount of  $90 \mu\text{g}/\text{cm}^2$  was realized.
- Weight gain was reduced to about 1/4 by Hi-F coat film under simulated NWC.
- Deposition amount of Co-60 was reduced to about 40% by Hi-F coat film under simulated NWC.

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