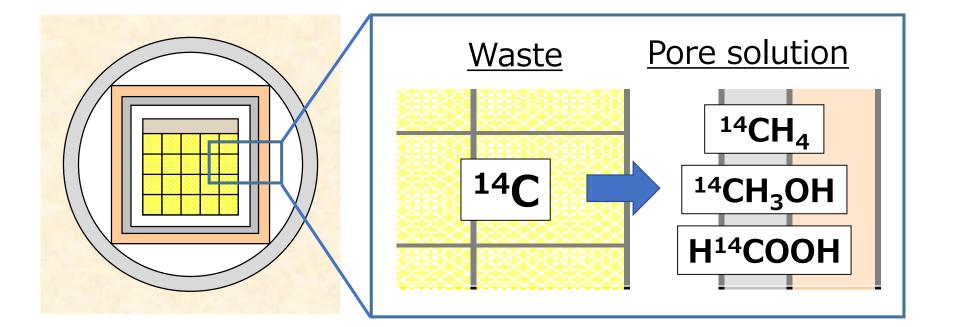
Identification of chemical form of carbon released from type 304L and 316L stainless-steel powders in alkaline and acidic solutions under low-oxygen conditions **Ryo NAKABAYASHI and Tomonari FUJITA**

Central Research Institute of Electric Power Industry (CRIEPI), JAPAN

r-naka@criepi.denken.or.jp

Introduction

• The chemical form of ¹⁴C released from the lowlevel waste (irradiated stainless steel) is a key parameter in the safety assessment of the subsurface disposal system in Japan.



Materials

- Type 304L and 316L stainless-steel powders
 - Water-atomized powders
 - Particle size : $< 150 \mu m$ (type 304L) < 45µm (type 316L)

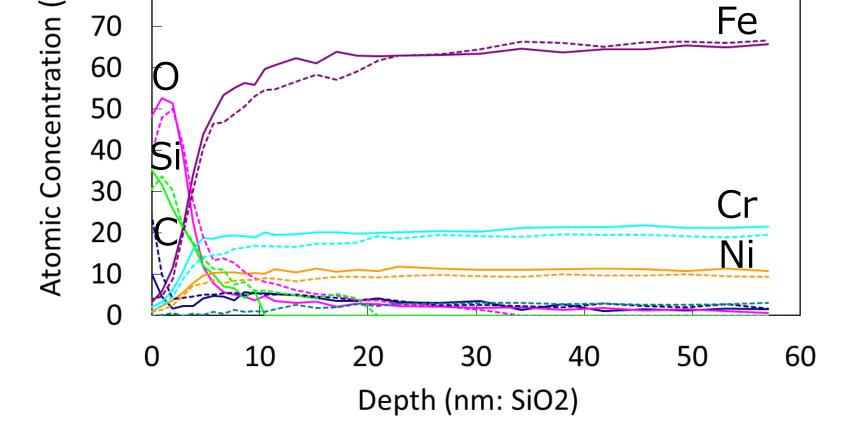
100 Solid line : Type 304L AES 90 (at%) Dashed line : Type 316L 80

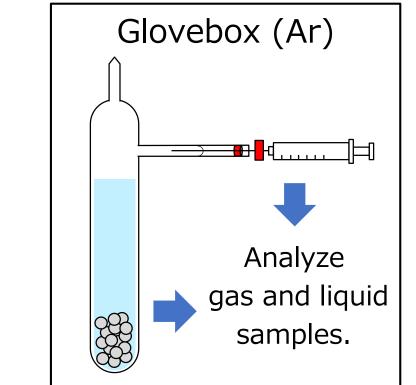
Immersion experiment

	Alkaline system	Acidic system
Mass of powder (g)	70	70
Vol. of solution (ml)	70	70
Type of solution	50mM NaOH (pH ~12)	50mM HCl (pH ~2)
Temperature (°C)	25	25
Duration (day)	25	20

Objectives

• Identify a chemical form of stable carbon released from non-irradiated stainless steel in acidic and alkaline solutions under low oxygen conditions.





- The collected liquid samples were divided into unfiltered and filtered samples.
- The filtered sample were filtrated using an ultrafiltration membrane (10,000 MWCO).

Liquid analysis results

Other elements and TOC Carbon species Type 304L system Type 316L system 250 104 104 Concentration (μmol/l) Concentration (אשסן/ו) **Colloidal carbon Colloidal carbon** 10^{3} 10^{3} Concentration (µmol-C/l) Alkaline system (Cr, Mn, Fe, Ni) (Cr, Mn, Fe, Ni) 200 10² 10² TOC **Colloidal carbon** 101 101 Acetaldehyde 150 **Colloidal carbon** 100 100 Formaldehyde **Carboxylic acid** 10-1 Oxalic acid 10^{-1} Unfiltered 100 Cr Mn Fe Ni Mo TOC Cr Mn Fe Ni Mo TOC Si Si sample Acetic acid Filtered Colloidal carbon (Cr) 104 104 oncentration (µmol/l) entration (µmol/l) Colloidal carbon (Cr) Formic acid 50 sample 10³ 10³ Ethanol Acidic system 10² 10² Methanol filtered unfiltered filtered unfiltered unfiltered unfiltered filtered filtered 10¹ 101 100 10^{0} 304L 304L 316L 316L 10-1 10-1 Alkaline system Acidic system

Colloidal carbon may be mainly formed in alkaline systems. \bullet

What is the colloidal carbon ?

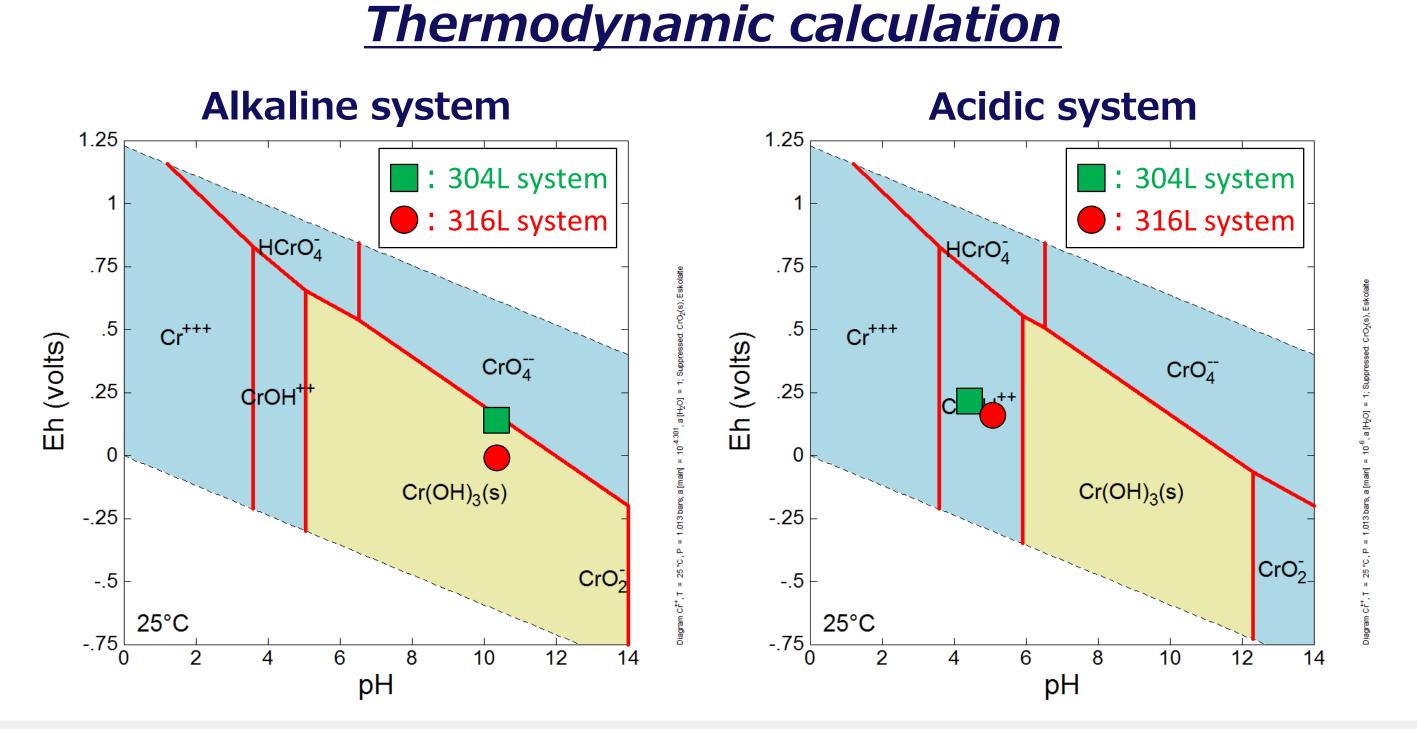
Colloidal carbon, formic and acetic acids may be formed in acidic systems.

Si Cr Mn Fe Ni Mo TOC	Si	Cr	Mn	Fe	Ni	Μο ΤΟϹ	
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• The chemical composition of the colloidal carbons appeared to be different between alkaline and acidic systems.

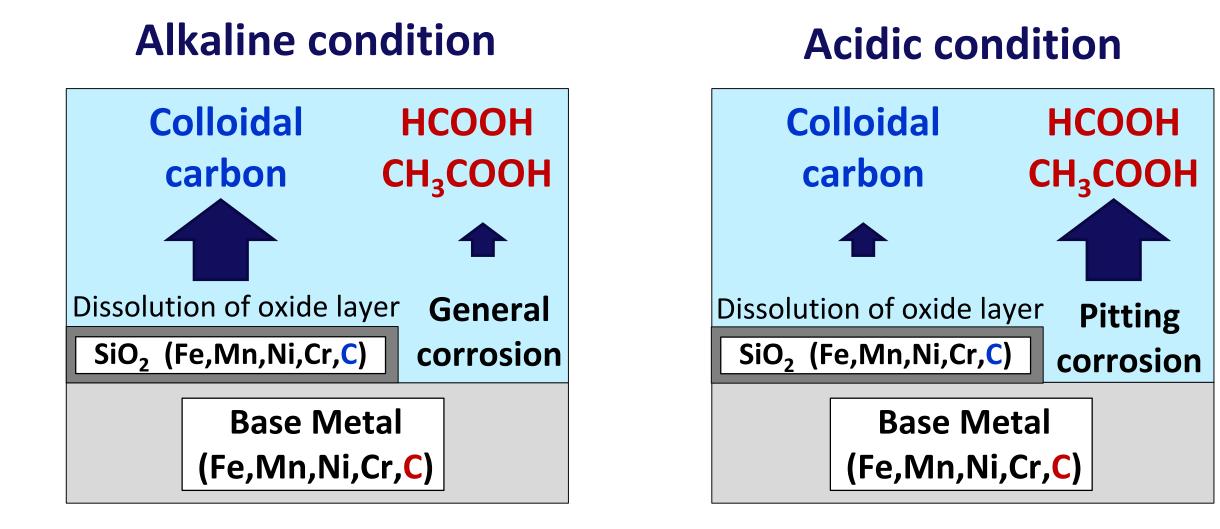
TEM analysis Cr 3041 tem /stem Ge lype Ś Cr Fe Ge Mo 100nn Alkaline **316L** tem **Ge**^{*} * Molybdenum **Type** Cr Fe **Ge**^{*} grid coated with Mo thin germanium 100nm film

- Carbon was accompanied by Fe, Cr, Si and O in colloidal particles.
- The colloidal carbon may be formed by interactions between C and Cr.



• Formation of hydroxide species isn't necessarily an immediate cause of the formation of colloidal carbon.

Why is the chemical form different in alkaline and acidic systems?



- We speculate that the difference of the site where carbon exist may affect the chemical form carbon.
 - Colloidal carbon originates from a silicon oxide layer, and
 - Formic and acetic acids originate from a base metal.
- A silicon oxide layer can easily be dissolved thermodynamically in alkaline systems but not in acidic systems.
- A corrosion rate at the interface of base metal in acidic systems is expected to be higher than in alkaline systems. This is because that we used a HCl solution and the pitting corrosion occurred in acidic systems.

