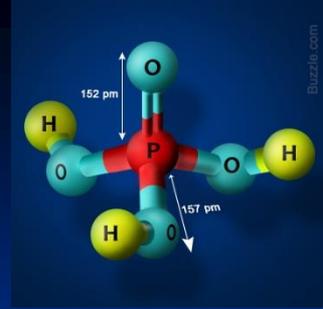


令和元年度リサイクル技術開発本多賞「3R先進事例発表会」



リン回収リサイクルの研究



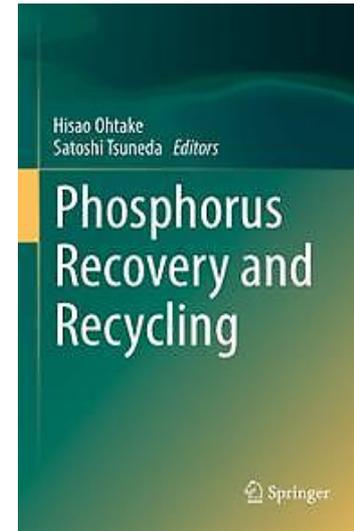
早稲田大学リンアトラス研究所 大竹久夫

Technology	Location and operator	Operational since	Recovered material or product
Onsite wastewater treatment plants			
AirPrex®	MG-Neuwerk (DE), Niersverband	2009	Struvite
	Wassmannsdorf (DE), Berliner Wasserbetriebe	2010	
	Echten (NL), Drents Overijsselse Delta	2013	
	Amsterdam-West (NL), Waternet	2014	
	Uelzen (DE), SE Uelzen	2015	
	Salzgitter Nord (DE), ASG	2015	
	Wolfsburg (DE), SE Wolfsburg	2016	
	Tianjin (CN), Tianjin CEPG	2016	
ANPHOS	Land van Cuijk (NL), Aa en Maas	2011	Struvite
Crystalactor®	Nanjing (CN), Royal Haskoning DHV	2010	Struvite
EloPhos®	Lingen (DE), SE Lingen	2016	Struvite
EXTRAPHOS (Budenheim)	MZ-Mombach (DE), Wirtschaftsbetrieb Mainz	2017 (pilot)	DCP
Gifhorn	Gifhorn (DE), ASG	2007	Struvite/CaP
Hitachi-Zosen (Unitika)	Matsue (JP)	1998	Struvite
	Senboku (JP), Senboku City	2009	HAP
J-Oil	Yokohama (JP), J-Oil Mills Co.		HAP
JSA	Kawasaki (JP), Japan Synthetic Alcohol Co.	1998	HAP
KURITA	Fukuoka (JP), 3 plants	1997	Struvite
Kyowa Hakko	Hofu (JP), Kyowa Hakko Bio Corp.	2006	HAP
MultiForm™	Yakima, WA		Struvite
	Boise, ID		
	Massey, MD, Jones Family Farms (dairy)		
	Green Bay, WI		
NASKEO	Castres (FR)	2015	Struvite
NuReSys®	Harelbeke (BE), Agristo	2008	Struvite
	2x Niewkuerke (BE), Clarebout Potatoes	2009/12	
	Waasten (BE), Clarebout Potatoes	2012	
	Geel (BE), Genzyme	2014	
	Leuven (BE), Aquafin	2013	
	Schiphol Airport (NL), Evides	2014	
	Land van Cuijk (NL), Logisticon	2015	
Apeldoorn (NL), Vallei & Veluwe	2016		
	Braunschweig Steinhof (DE), SE/BS / AVB	2018/19	
PEARL® (OSTARA)	Tigard, OR, Clean Water Services	2009	Struvite (Crystal Green®)
	Suffolk, VA, Hampton Roads Sanit. District	2010	
	York, PA, City of York	2010	
	Hillsboro, OR Clean Water Services	2012	
	Slough (UK), Thames Water	2013	
	Saskatoon, SK, City of Saskatoon	2013	
	Madison, WI, Madison Metro. Sew. Distr.	2014	
	Burford, GA, Gwinnett County	2015	
	Amersfoort (NL), Vallei & Veluwe	2015	
	Edmonton, AB, EPCOR Water Services	2015	
	Stickney, IL, Metro. Water Recl. Chicago	2016	
	Reno, NV, Cities of Reno and Sparks	2016	
	Madrid (ES), Canal de Isabel II	2016	
	Winchester, VA, F. Winchester Service A.	2016	

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Phosphorus Recovery and Recycling
 Editors: H. Ohtake and S. Tsuneda (Eds.)
 Springer Nature

世界で約70のリン回収プラ
 ントが稼動しています。



PHORWater	Calahorra (ES), El Cidacos	2015 (demo)	Struvite
PHOSPAQ™	Olburgen (NL), Waterstromen	2006	Struvite
	Lomm (NL), Waterstromen	2008	
	Nottingham (UK), Severn Trent Water	2014	
	Tilburg (NL), Waterchap de Dommel	2016	
PhosphoGREEN (SUEZ)	Aaby (DK), Aarhus Water	2013	Struvite
	Marselisborg (DK), Aarhus Water	2018	
	Herning (DK), Herning Water	2016	
REPHOS® (delivered by NuReSys)	Altentreptow (DE), Remondis Aqua (dairy)	2006	Struvite
STRUVIA™	Helsingør Southcoast (DK)	2015	Struvite
Stuttgart	Offenburg (DE), AZV	2011 (demo)	Struvite (after acid leaching)
	Mobile Pilot – MSE Mobile		
	Schlammentwässerungs GmbH	2015 (pilot)	
Swing	Kobe (JP), Swing Corp.	2012	Struvite
Downstream wastewater treatment plants and ashes			
EcoPhos	Varna (BG), DecaPhos	2016	H ₃ PO ₄ /DCP/ MCP
	Dunkerque (FR), EcoPhos	construction	
Fertiliser industry	Various companies already apply or consider use of secondary P sources	tested and intended	Commercial fertiliser
MEPHREC	Nürnberg (DE), SUN	2016 (demo)	P-slag
METAWATER	Gifu (JP)	2010	HAP
	Tottori (JP)	2013	
Nippon PA	Chiba (JP), Nippon Phosphoric Acid	2009	H ₃ PO ₄
TetraPhos®	Hamburg (DE), Remondis Aqua	2015 (pilot)	H ₃ PO ₄
RecoPhos	ICL	intended	P ₄

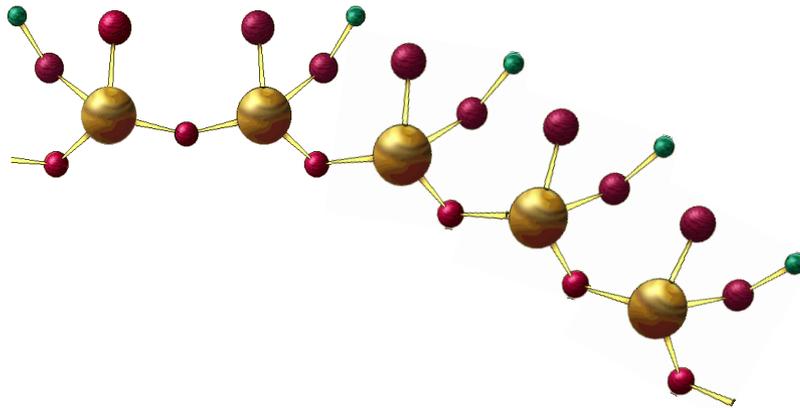
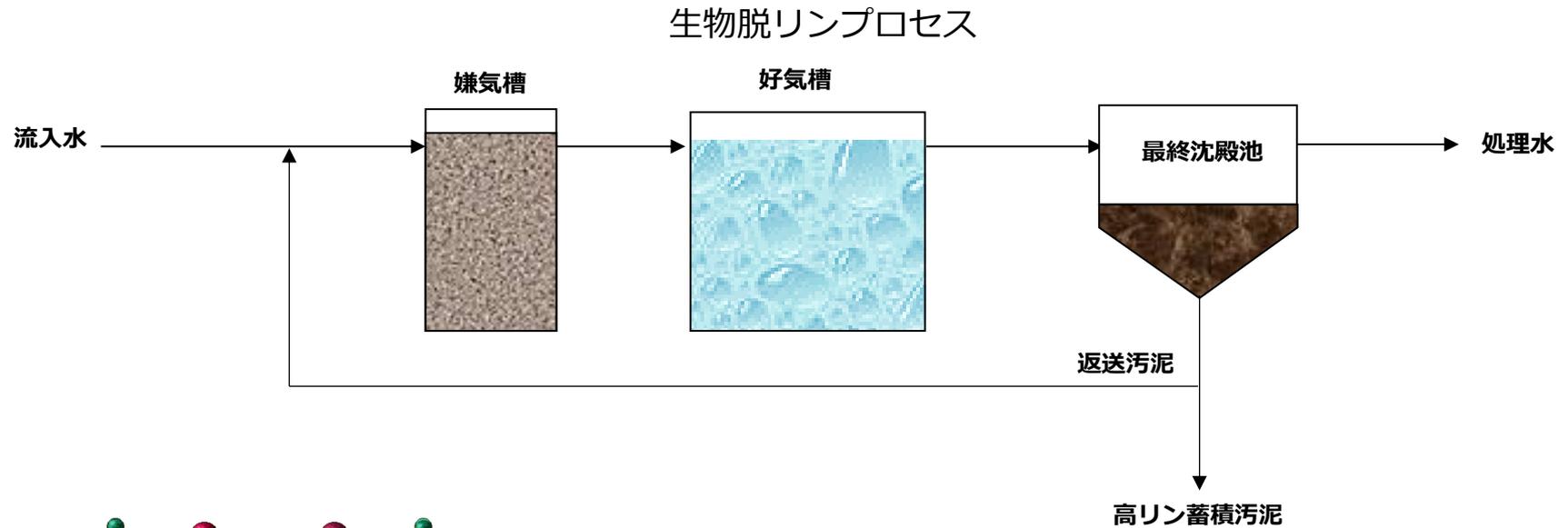
Kabbe C., Remy, C., and Kraus, F. (2015)

Chapter 35

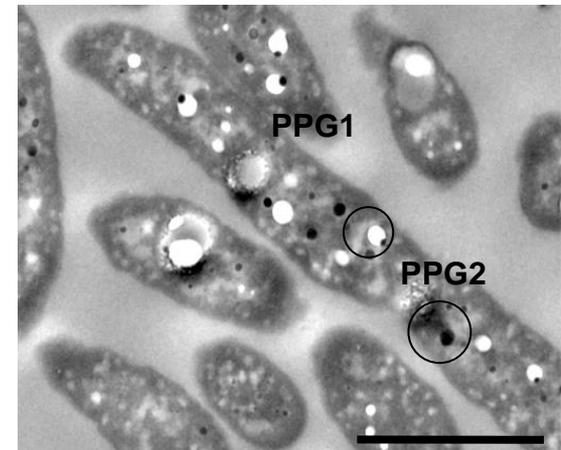
Heatphos Process for Recovering Phosphorus from Bio-P Sludge Before Anaerobic Digestion

N. Takiguchi, A. Kuroda, H. Ohtake, and S. Tsuneda

嫌気性消化前の生物脱リン汚泥からリンを回収するためのHeatphosプロセス

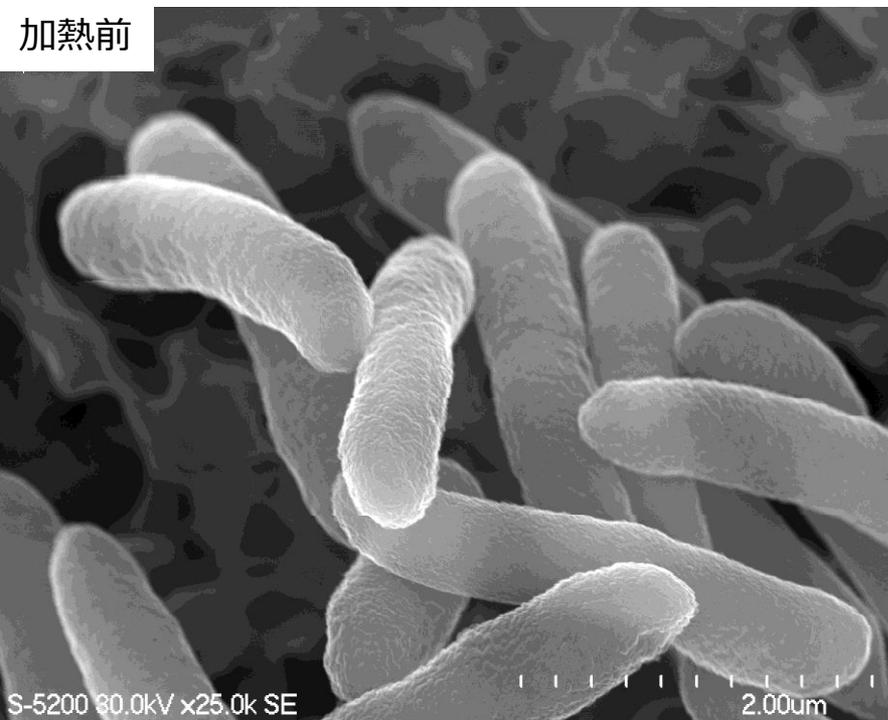


微生物が細胞内に蓄積するポリリン酸は、鎖長が1,000にも達する。

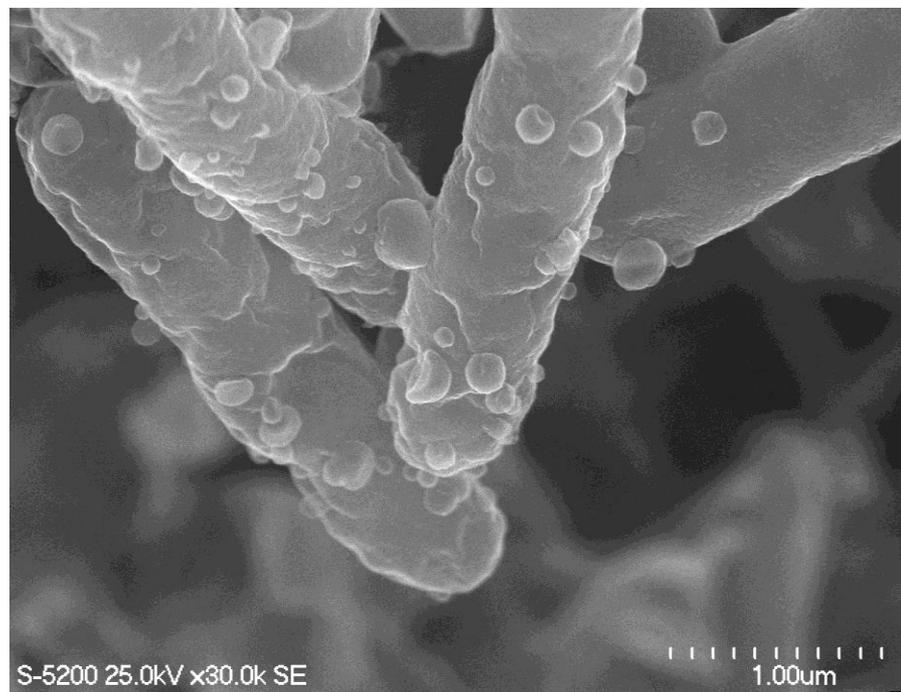
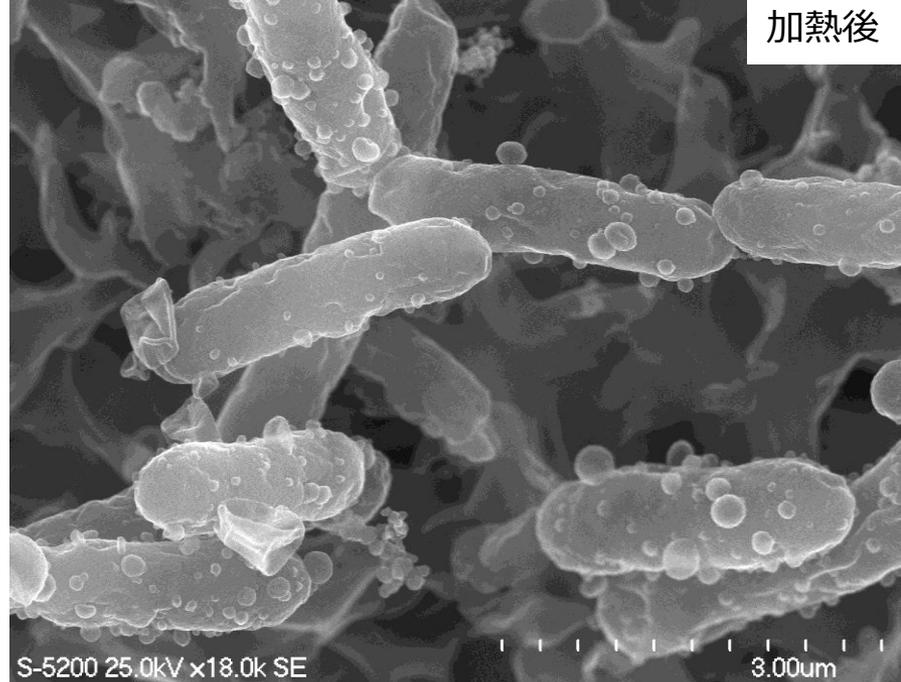


微生物細胞を70°Cで約1時間加熱すると細胞に穴があく。

加熱前

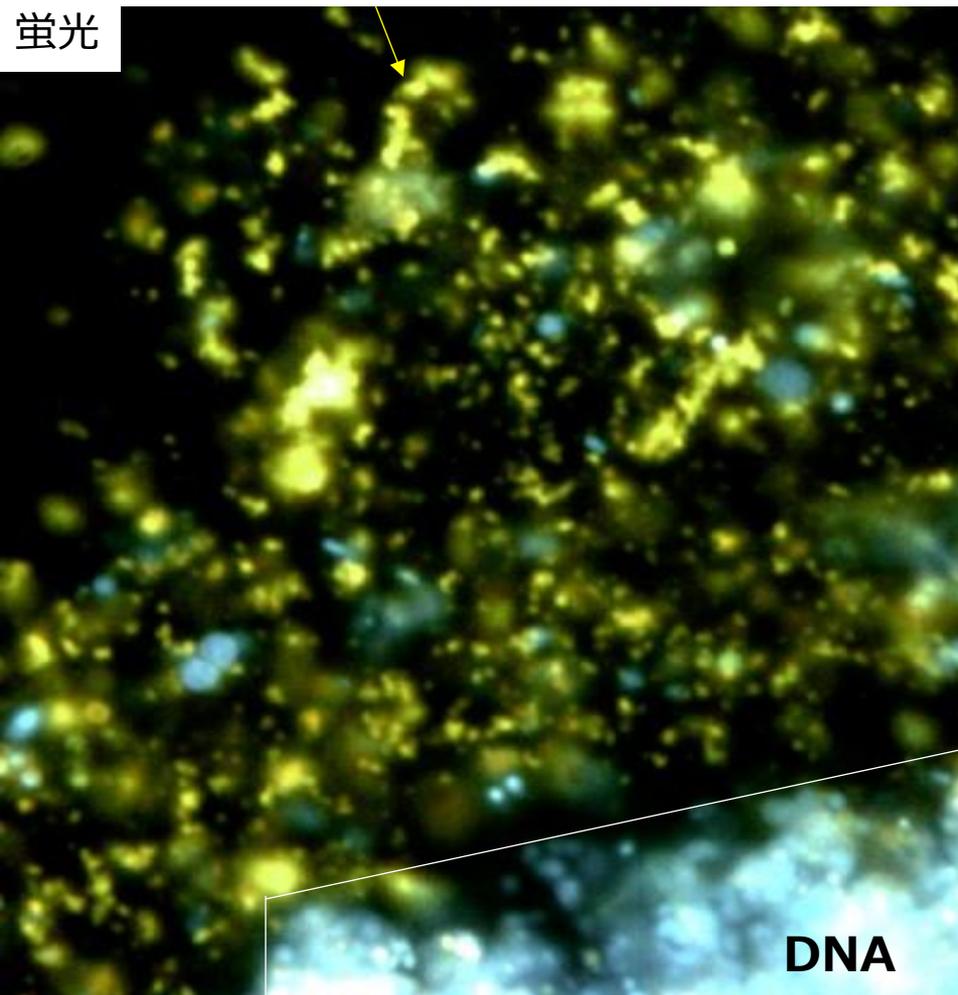


加熱後

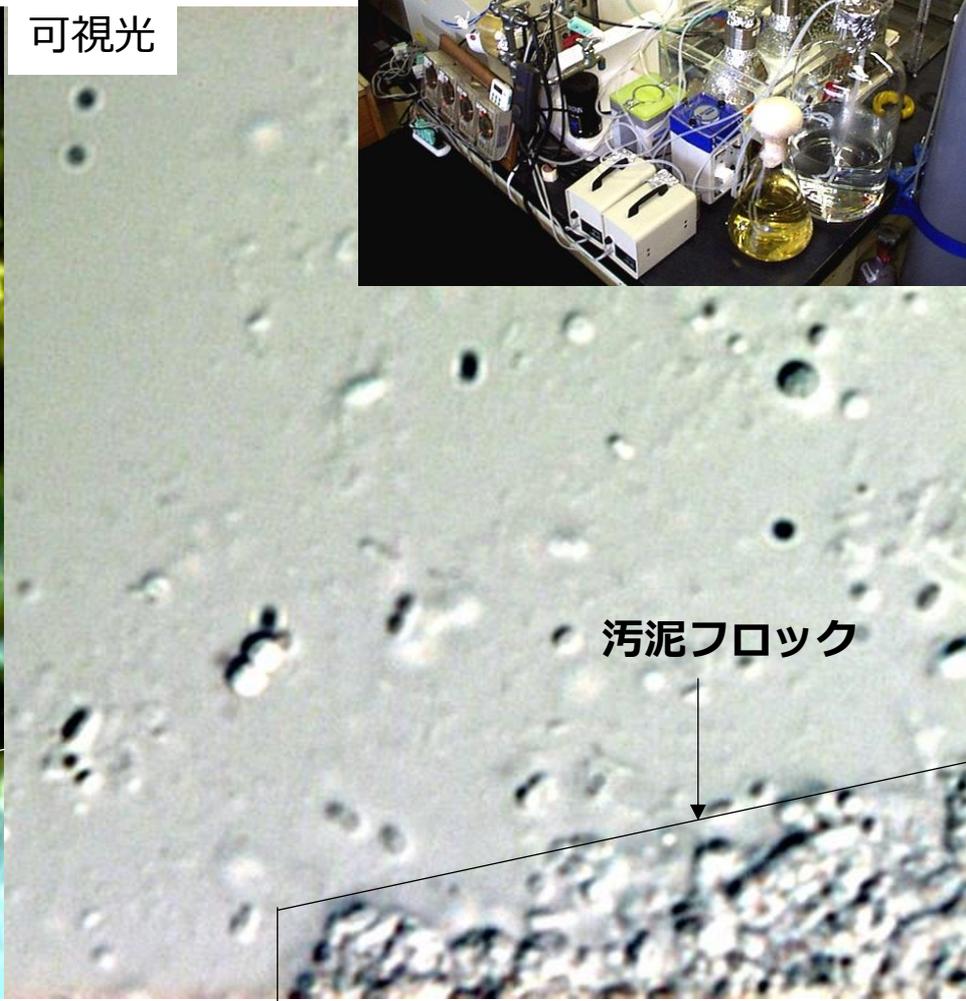


DAPI染色されたポリリン酸

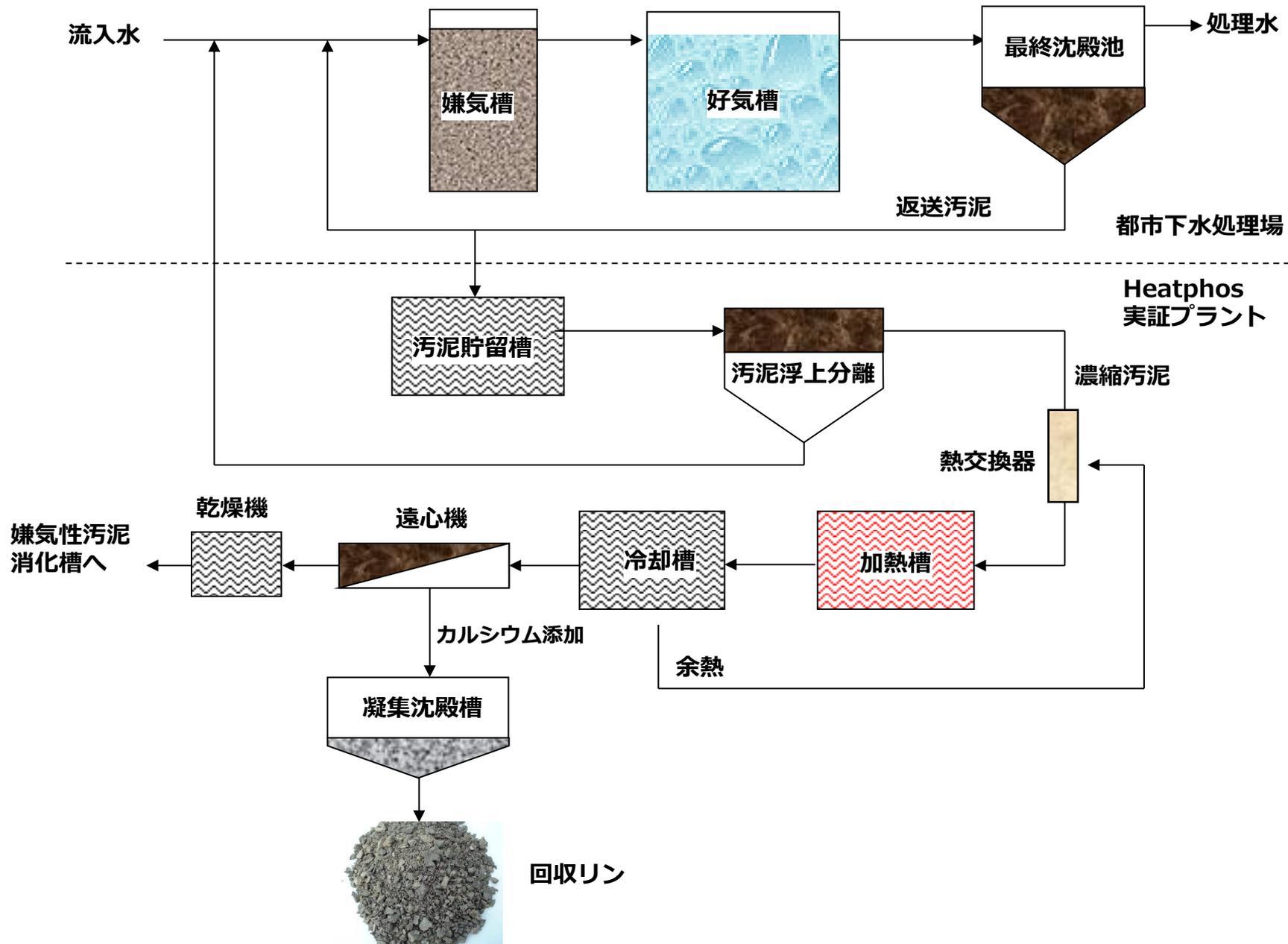
蛍光



可視光



活性汚泥を70℃で1時間加熱すると、ポリリン酸が放出される！





パイロットプラント実証試験
神戸市東灘下水処理場

メタンも発生しやすくなる！

実規模実証試験
福山市芦田川浄化センター

バイオリン鉱石 (10 kgP/日) 製造



Chapter 30

Phosphate Recovery Using Amorphous Calcium Silicate Hydrates

K. Okano, H. Ohtake, M. Kunisada, H. Takano, and M. Toda

非晶質ケイ酸カルシウムを用いたリン回収



ケイ酸カルシウムは安価な副産物

製鋼スラグやコンクリートスラッジなど

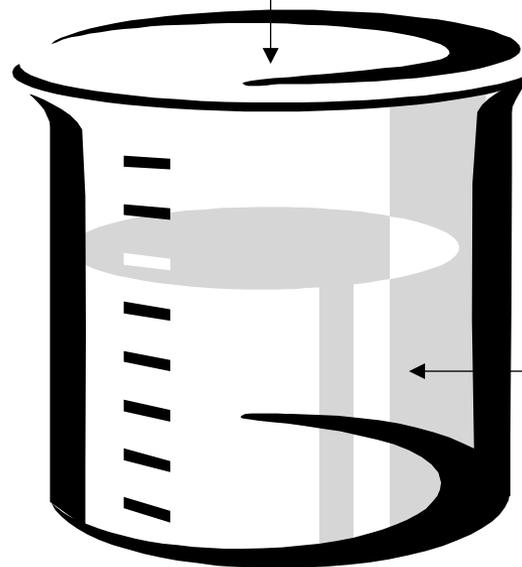


非晶質ケイ酸カルシウムの製造方法



ケイ酸カルシウム副産物

製鋼スラグ、コンクリートスラッジなど

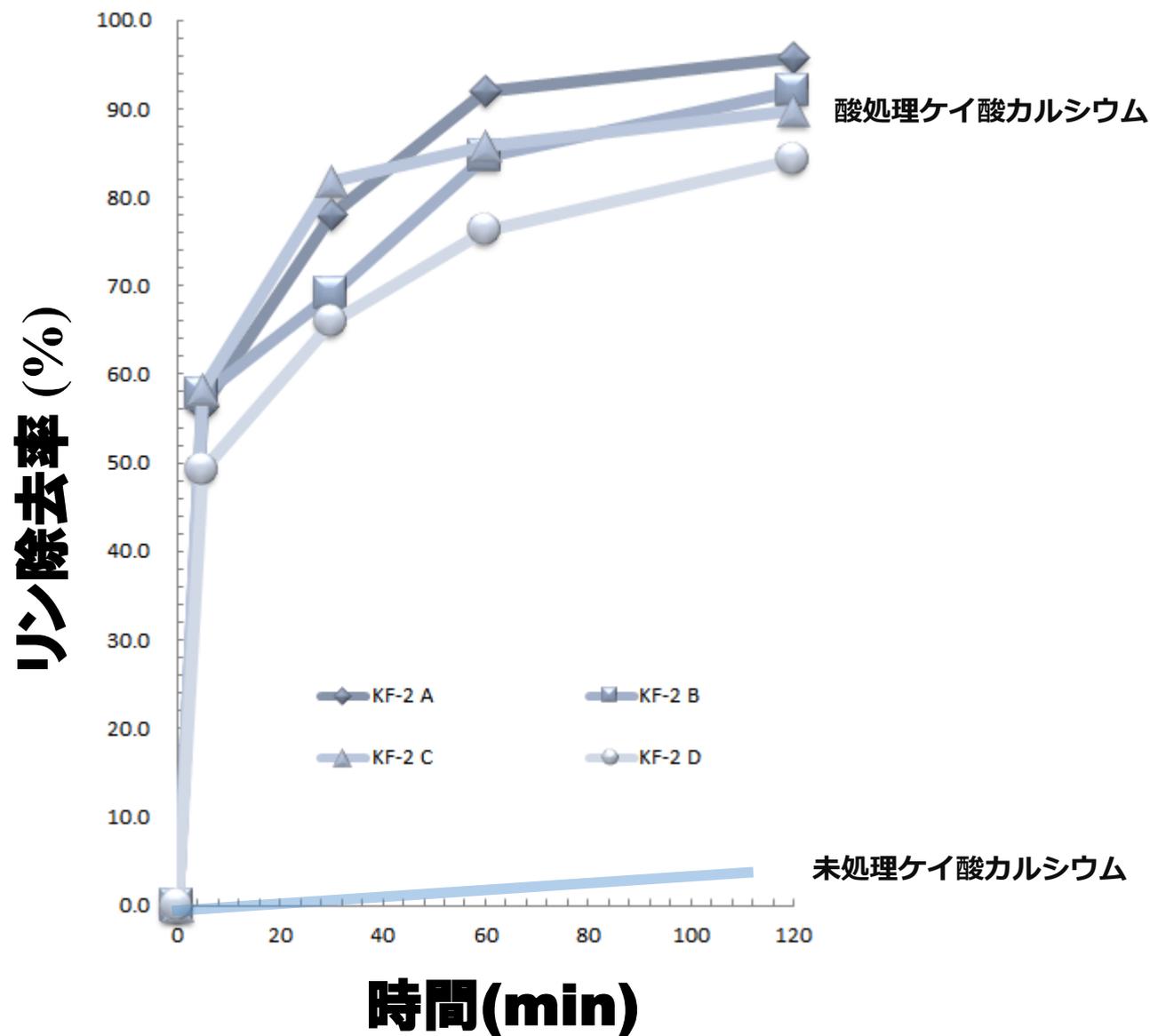


1 M HCl

非晶質ケイ酸カルシウム

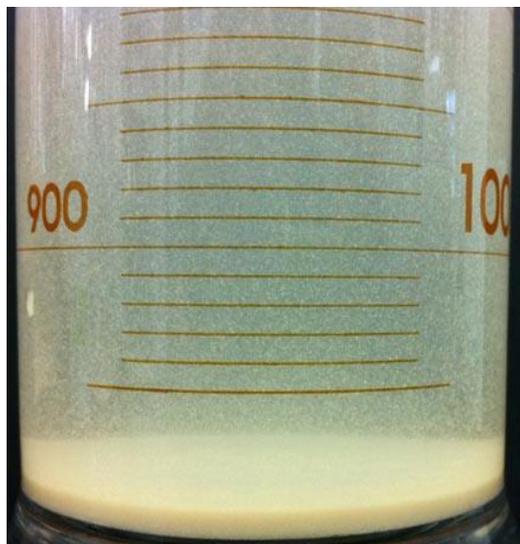


非晶質ケイ酸カルシウムは高いリン酸吸着能を示す！



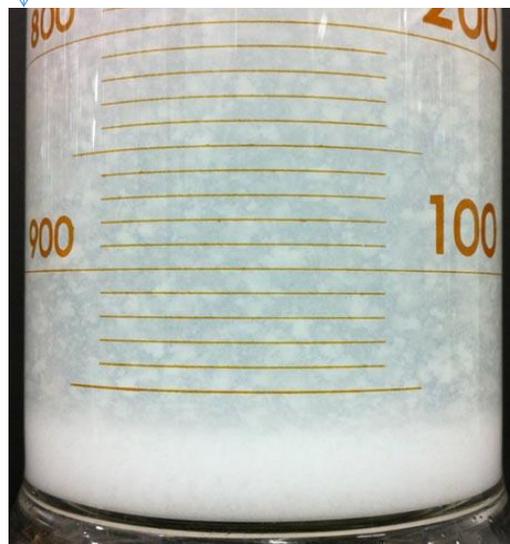
非晶質ケイ酸カルシウムは高い沈降性を示す！

非晶質ケイ酸カルシウム添加



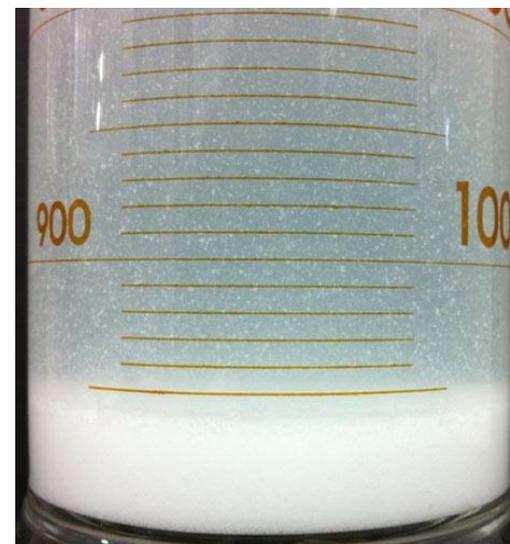
High Cl⁺
High Ca²⁺

CaCl₂添加

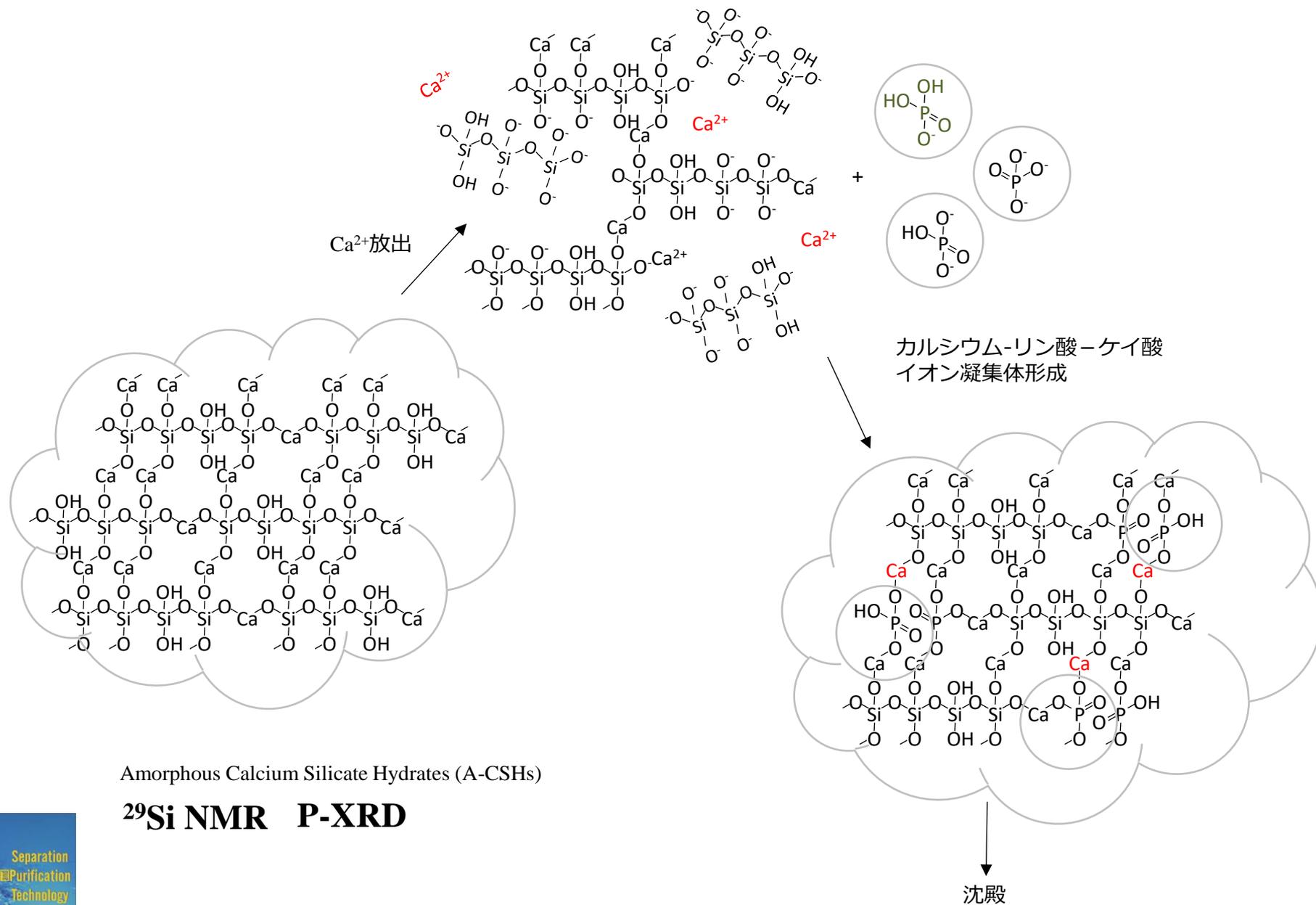


High pH
High Ca²⁺

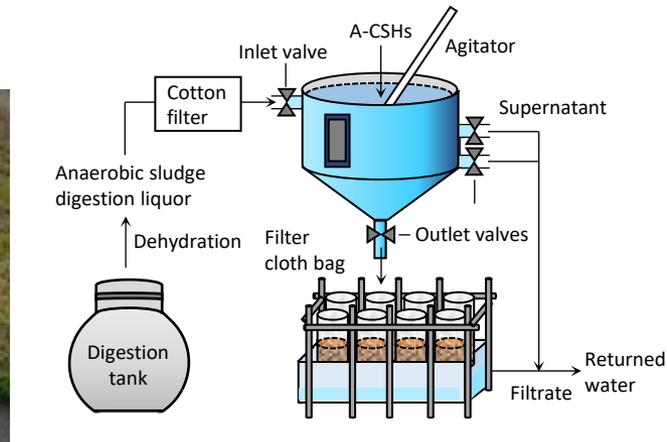
Ca(OH)₂添加



非晶質ケイ酸カルシウムは吸着剤と凝集剤の機能を合わせ持つ！



移動可能型リン回収装置



回収品はそのまま副産りん酸肥料に！



持続可能なリンバリューチェーン

単一の技術イノベーションでは解決できない。

