Kick off WS, Feb. 29, 2016
(NSTDA, Thailand)

Clean and Efficient Utilization of Low Rank Coals and Biomass by Solvent Treatment Method

On behalf of SATREPS group

Development of clean and efficient utilization of low rank coals and biomass by solvent treatment

Japan

Head Investigator: Kouichi Miura

Research fund: 178 million yen from JST

Thailand

Head Investigator: Bundit Fungtammasan

Research fund: 300 million yen from JICA

Japan side

Institute of Advanced Energy and Grad. School of Engineering, Kyoto U. **Miura Gr.**

Akita University: **Sugawara Gr.**

CRIEPI: **Makino Gr.**

Kobe Steel Co. Ltd: **Okuyama Gr.**

Thai

JGSEE/KMUTT: **Bundit Gr.**

PTT Research and Technology Institute, PTT Public Company Ltd: **Suchada Gr.**

2014 – 2018 JFY

Degradative Solvent Extraction

- Upgrading and Dewatering are essential.
  - Prof. Miura group has developed a novel degradative solvent extraction method that realizes dewatering and upgrading of low rank coals simultaneously.
  - This method removes water without phase change and reduces oxygen functional groups in the coal without cross-linking reactions through mild heat-treatment of coal in non-polar solvent.

Ashida, R.; Morimoto, M.; Makino, Y.; Umemoto, S.; Nakagawa, H.; Miura, K.; Saito, K.; Kato, K. *Fuel* **2009**, *88*, 1485-1490.

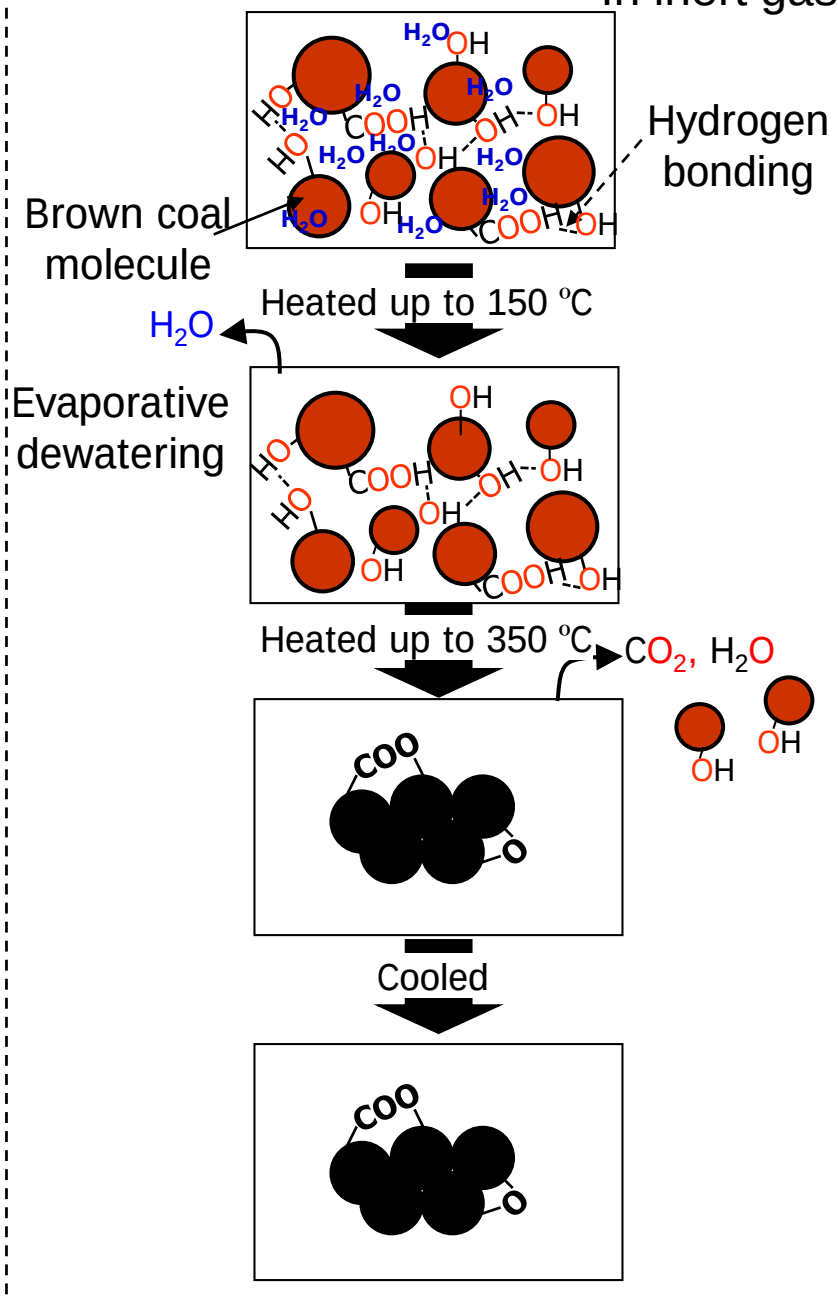
Miura, K.; Hasegawa, Y.; Ashida, R. *Prepr. Pap. - Am. Chem. Soc., Div. Fuel Chem.* **2009**, *54*, 870-871.

X. Li, R. Ashida, K. Miura, *Energy & Fuels*, **2012**, *26*, 6897-6904.

J. Wannapeera, X. Li, N. Worasuwannarak, R. Ashida, K. Miura, Energy & Fuels, **2012**, *26*, 4521-4531.

Conventional heat-treatment

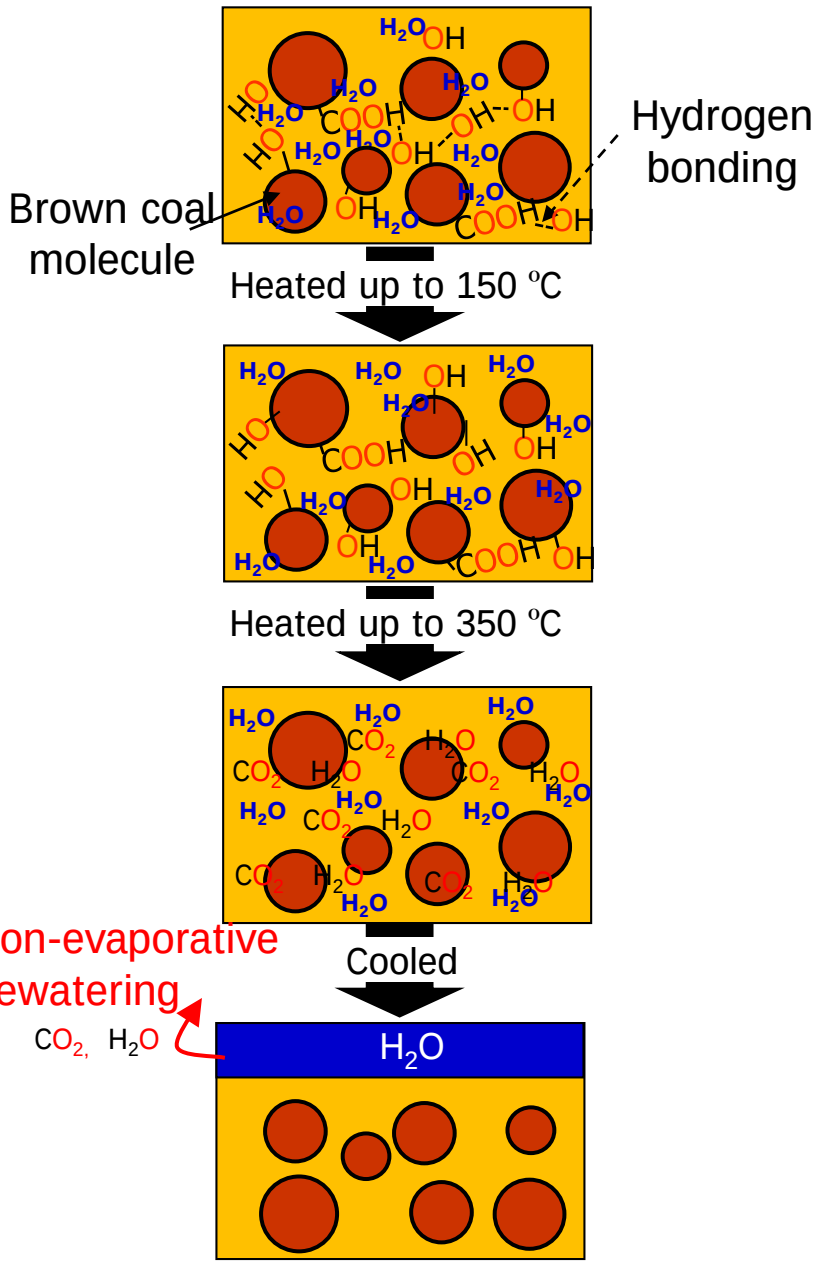
In inert gas



Significant enlargement of the coal molecules.

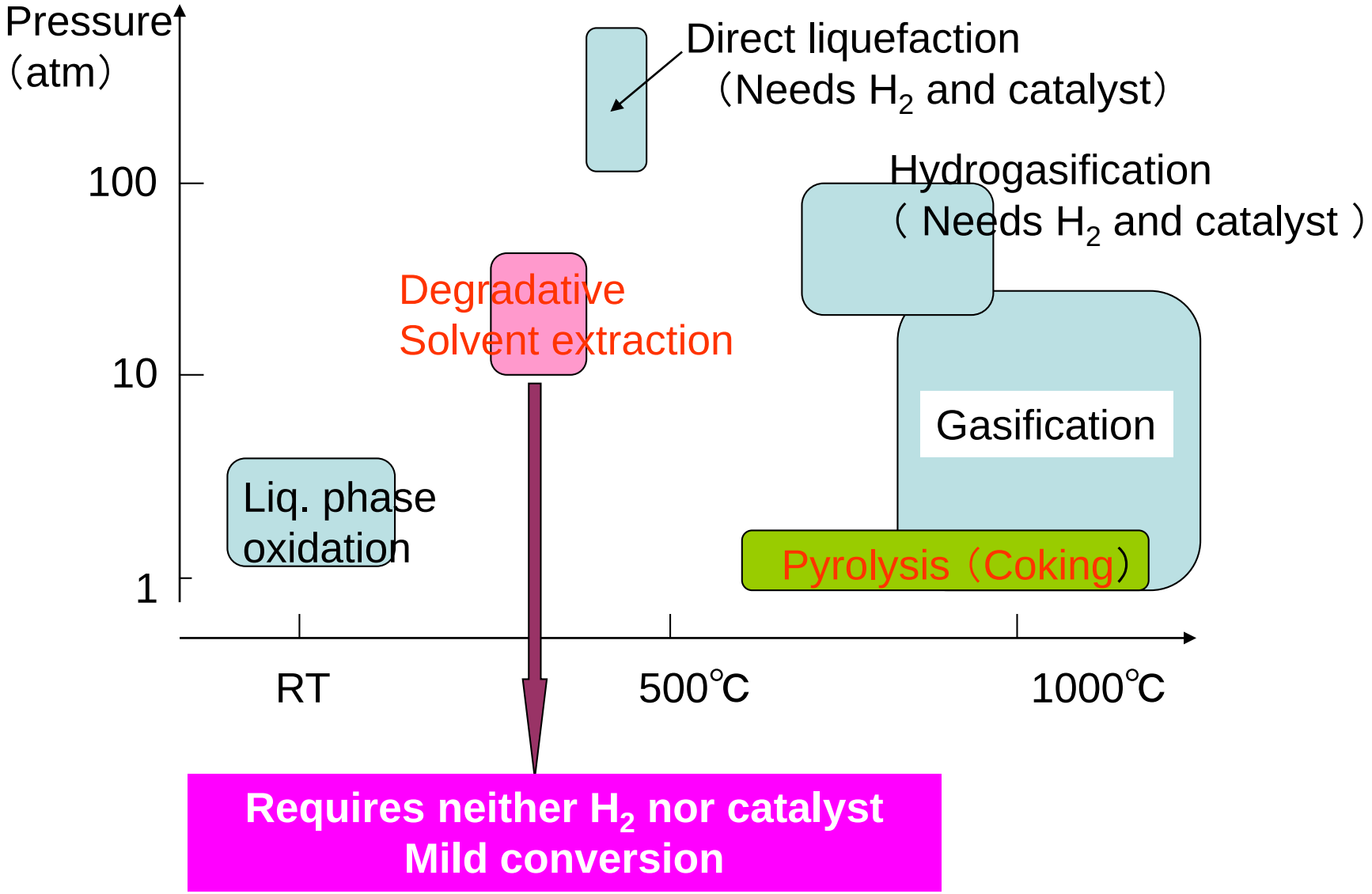
This method

In non-polar solvent

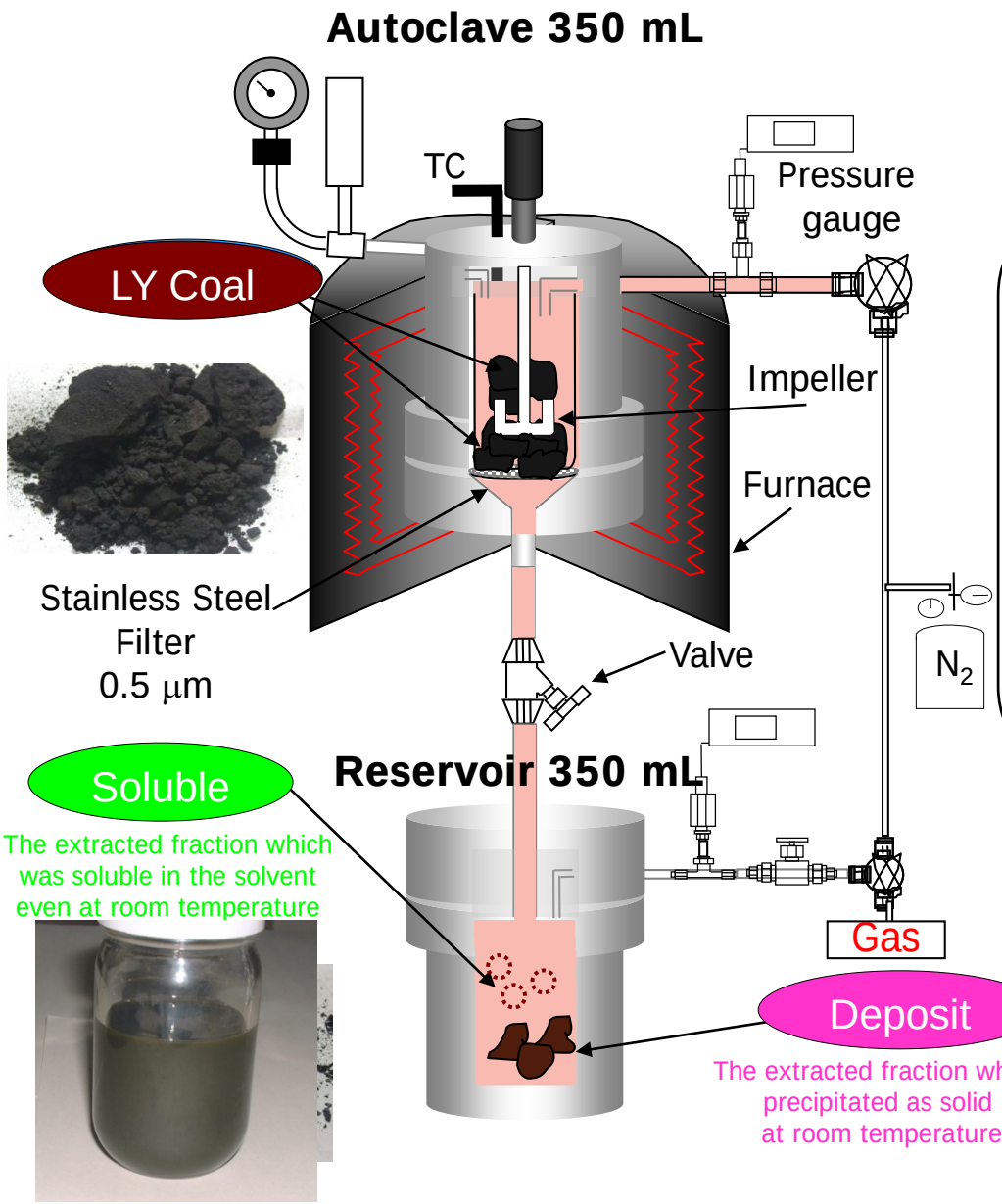


Upgrading without cross-linking reactions.

Operating Conditions of Coal Conversion Processes



Apparatus and procedure



Experimental conditions

- Coal: 14 g-d.a.f.
  (Charged as received)
- 1-MN : 300 mL
- Temperature : 350°C
- Holding time : 0, 1, 2, 3 h
- Final pressure : 2.3, 6.8, 15.7 MPa

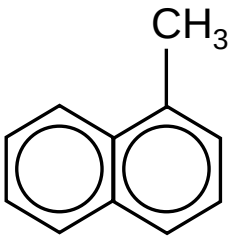
Apply to different Biomass wastes

Samples used

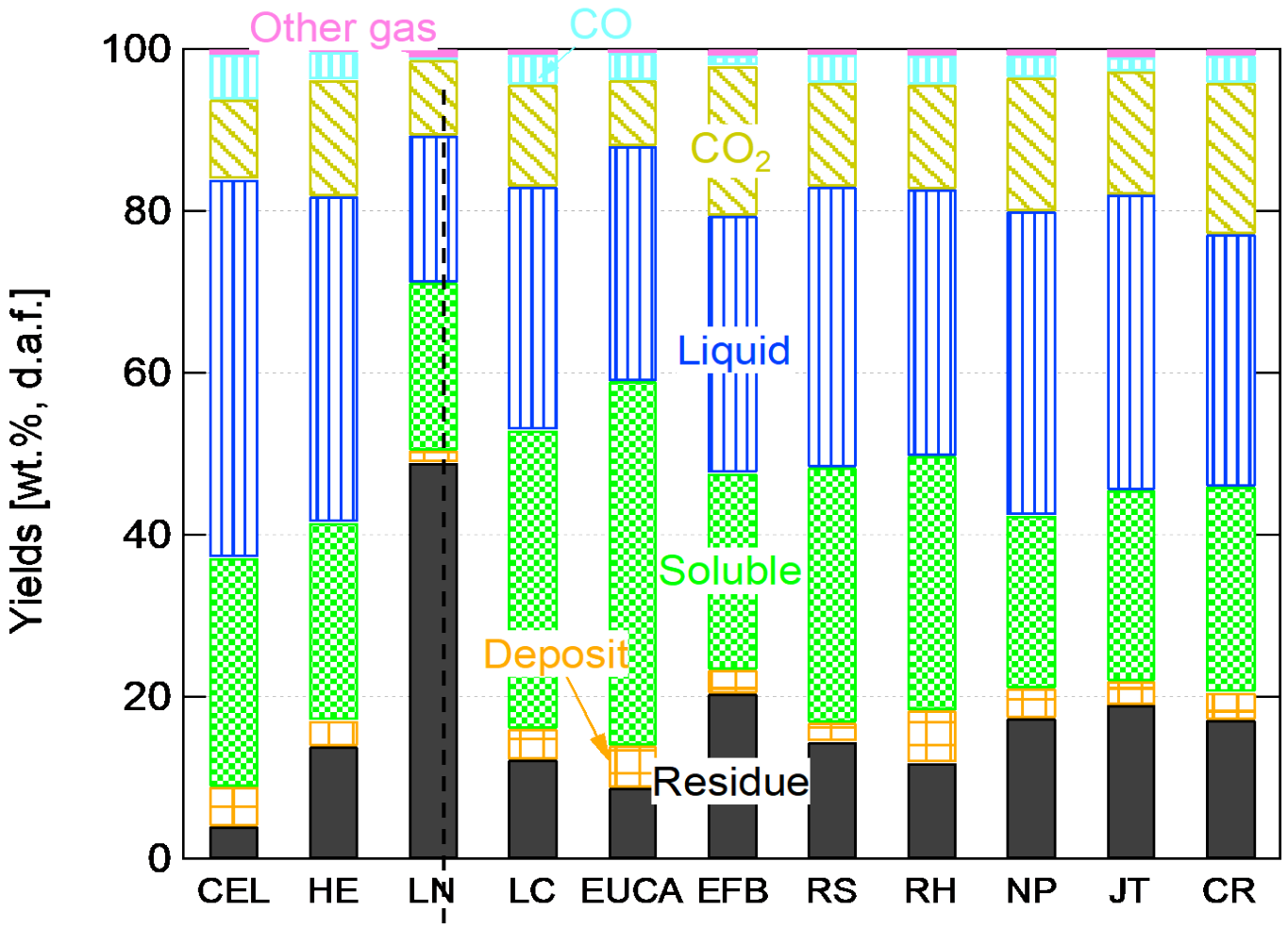
	Structural composition (wt.%, d.a.f.)			
	Extractive	**Cellulose**	**Hemicellulose**	**Lignin**
Leucaena (LC)	8.0	33.1	31.8	27.1
Eucalyptus (EUCA)	2.4	36.9	28.0	32.7
Empty fruit bunch(EFB)	3.4	42.5	26.1	28.0
Rice straw (RS)	6.2	33.5	43.8	16.5
Rice husk (RH)	9.4	32.1	36.2	22.3
Napier grass (NP)	13.3	29.1	42.1	15.4
Jatropha trunk (JT)	6.7	31.9	38.3	23.1
Cassava rhizome (CR)	11.1	29.1	33.9	25.9

Solvents used

1-Methylnaphthalene (1-MN)

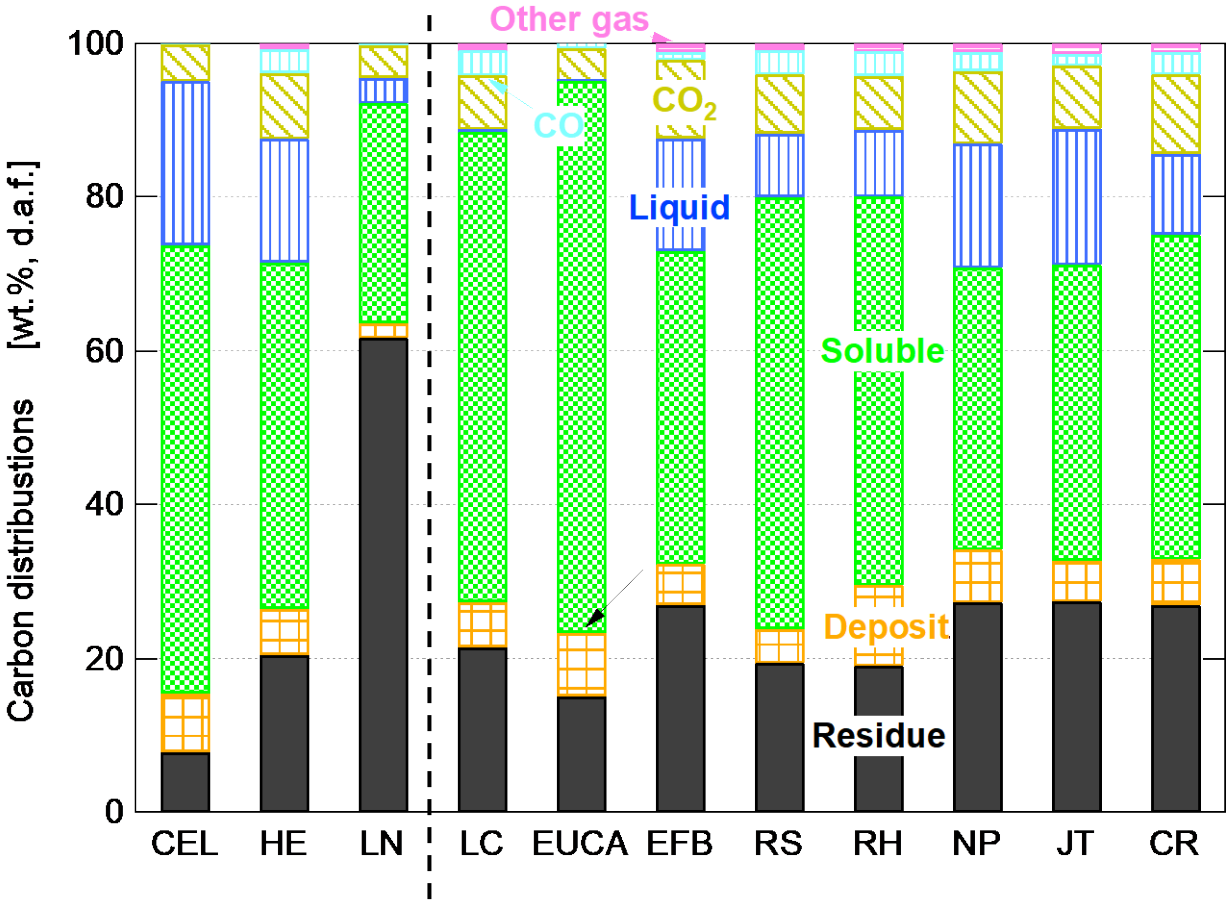


Yields through the treatment



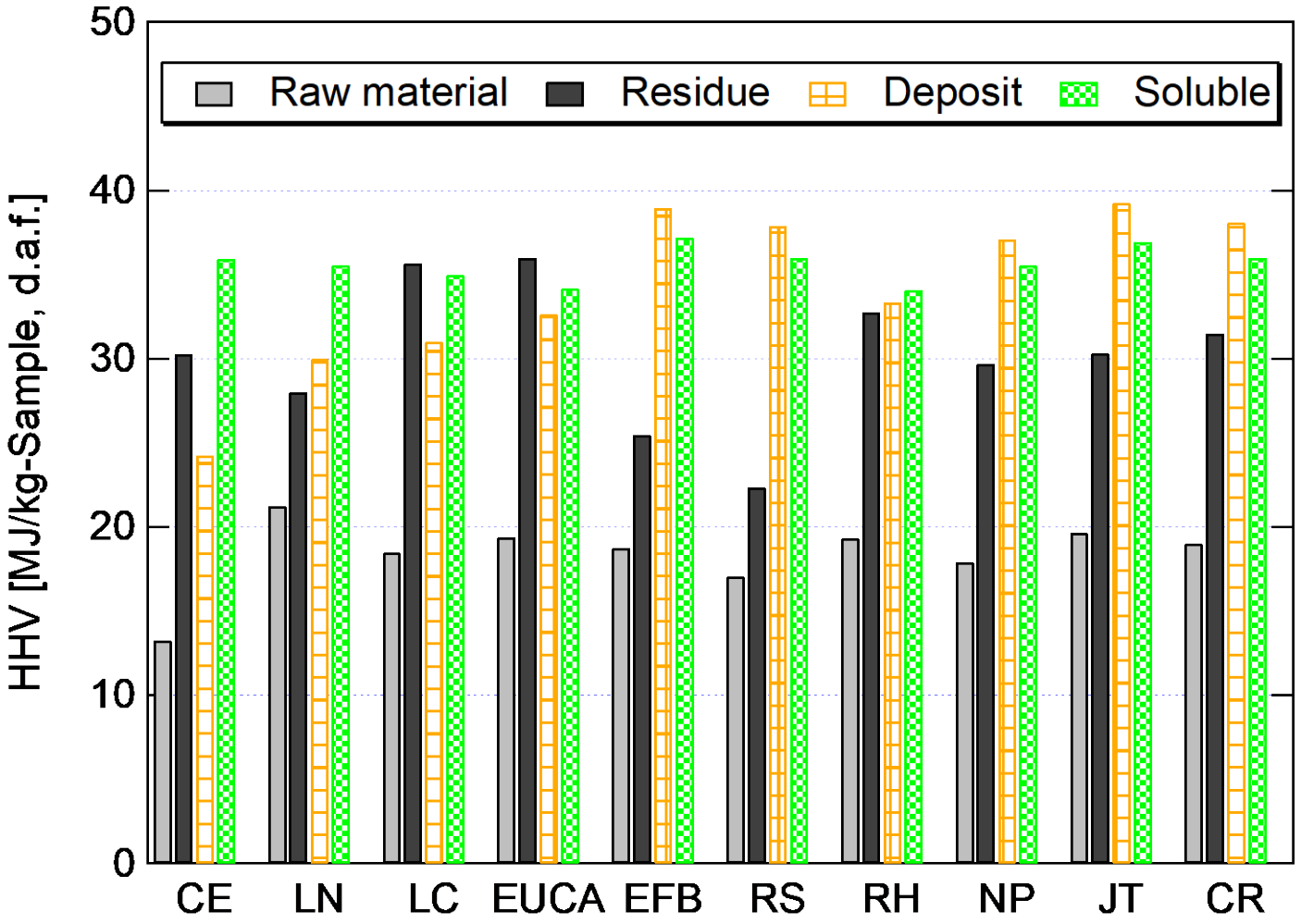
- **Soluble** yields reached 20 – 45 % on weight basis for wastes.
- Liquid is the fraction recovered with solvent.

Carbon based yields



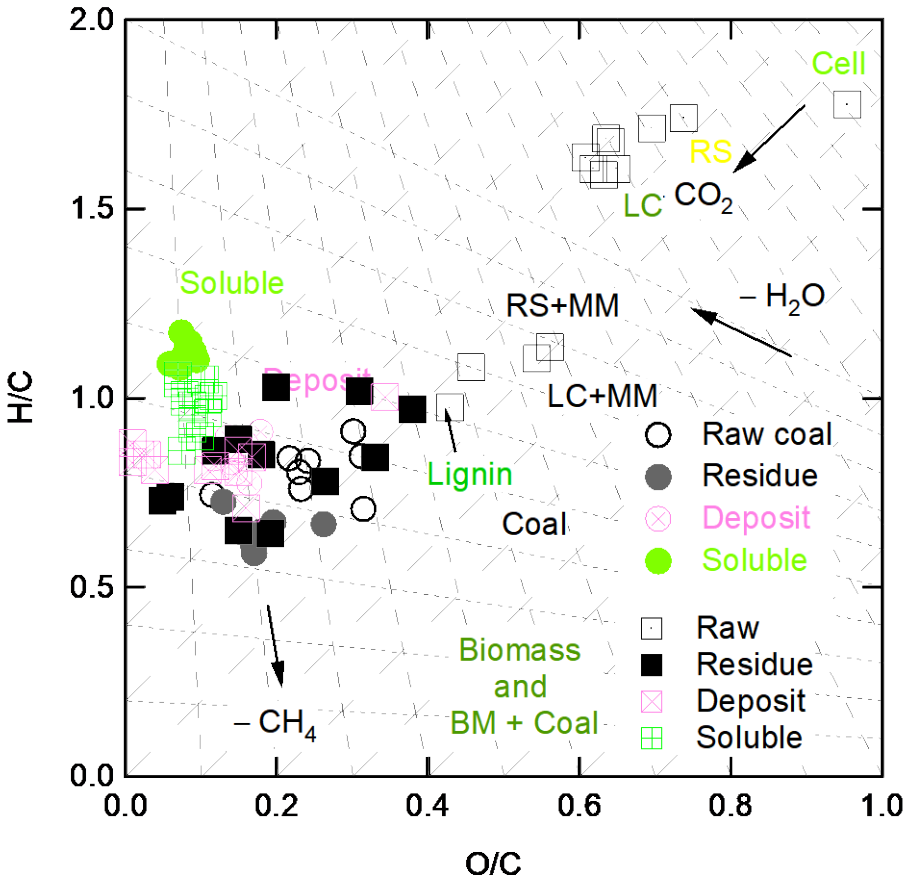
- **Soluble** is the largest fraction of decomposed products.
- **Soluble** yields are very large and reached more than 70 % for EUCA.
- Liquid fractions consisted mostly of H_2O.

Heating Values of Raw and Upgraded Samples



- Heating values of Deposit and Soluble are very high on sample basis

Elemental Compositions on H/C vs. O/C diagram



Soluble

C content: 80 — 83 %
H content: 6.5 — 7.5 %
Ash : 0 — 0.10 %
HHV : 35 — 36MJ/kg

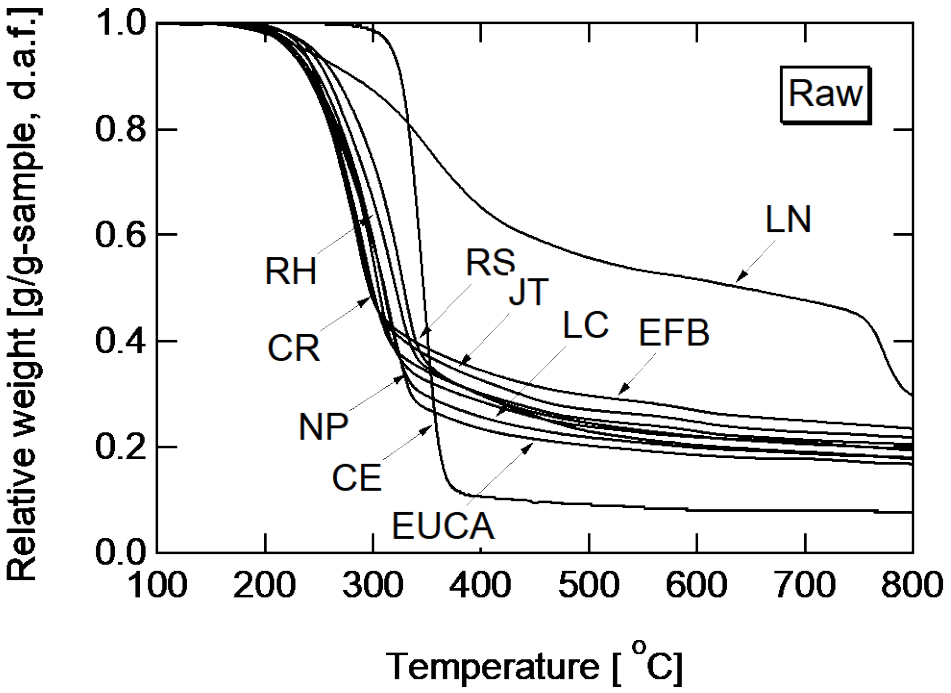
Deposit

C content: 75 — 78 %
H content: 5 — 6 %
Ash : 0 — 0.16 %
HHV : 30 — 31 MJ/kg

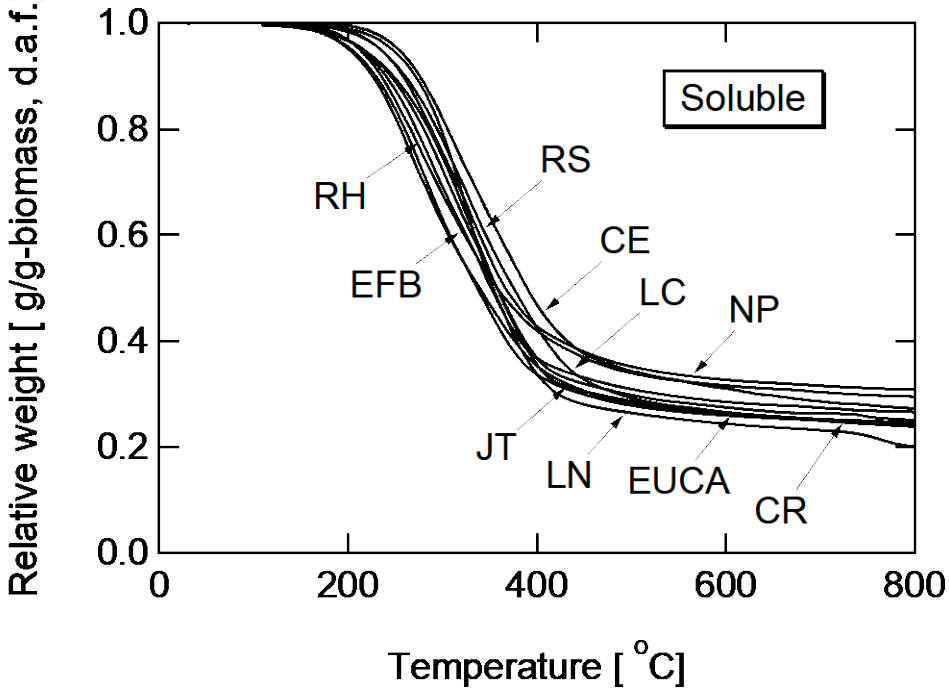
- Elemental compositions of Solubles are very close to each other for both coal samples and biomass samples.
- **Solubles** are almost free from ash, and rich in C and H

Thermogravimetric Analyses

Raw material

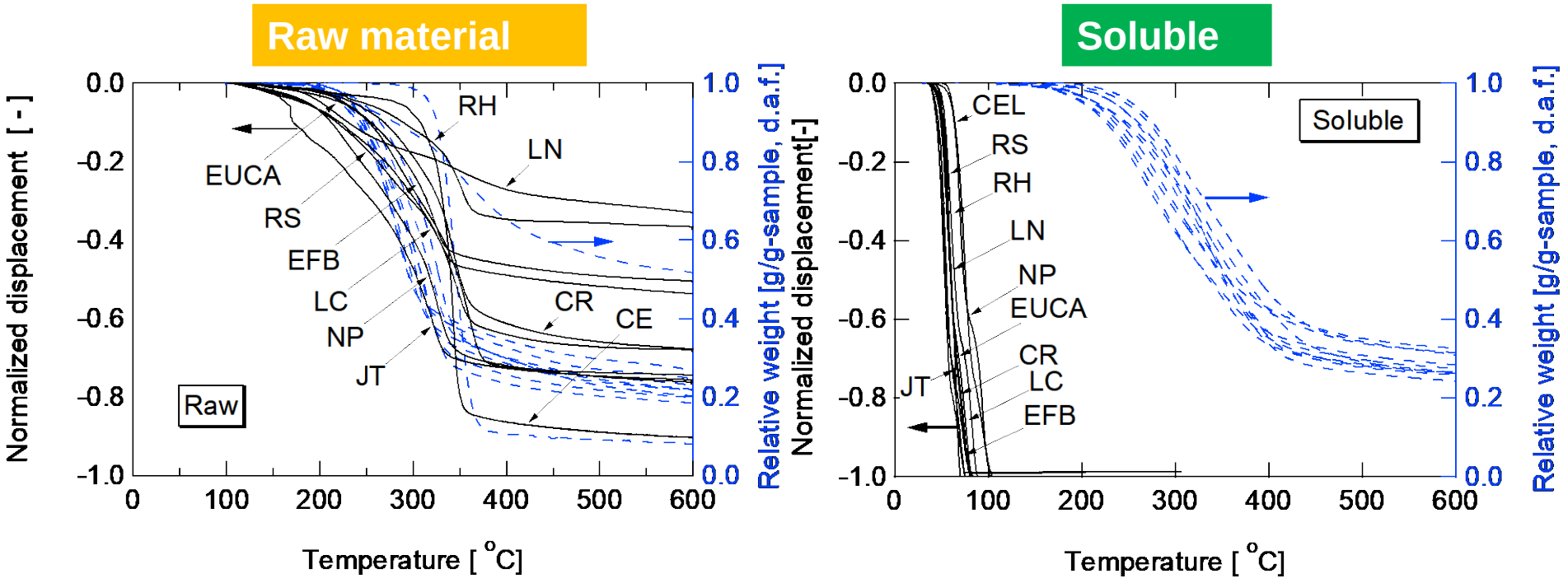


Soluble



- TG curves of Solubles are very close each other.
- About 80 % of Soluble are volatile.

Thermogravimetric and Thermomechanical Analysis



- TG and TMA curves of Solubles are very close each other
- About 80 % of Soluble are volatile.
- All Solubles completely soften and melt below 100 ℃
- Displacement of raw samples is due to the weight loss through pyrolysis.

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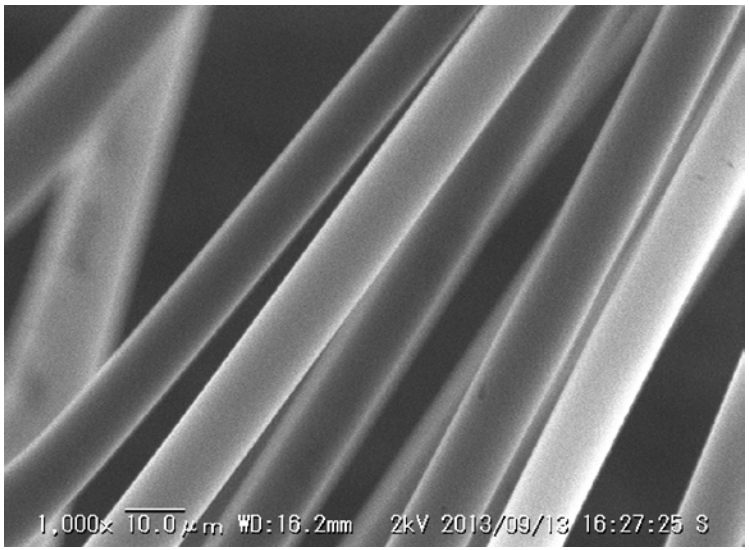
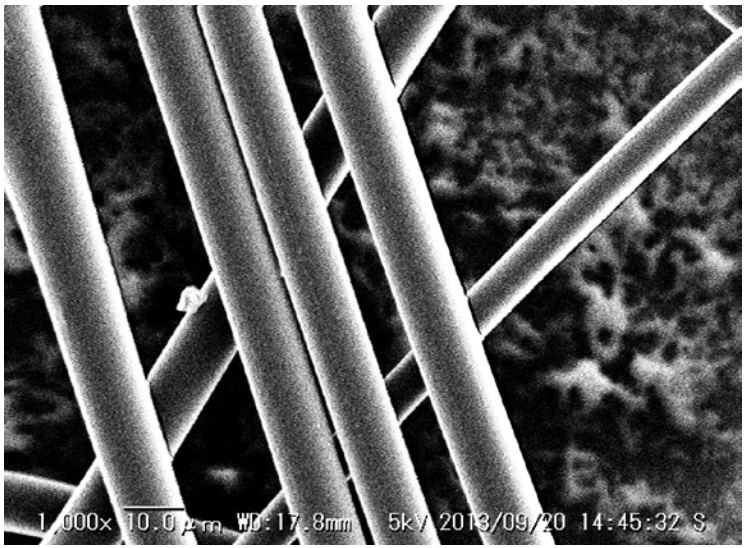
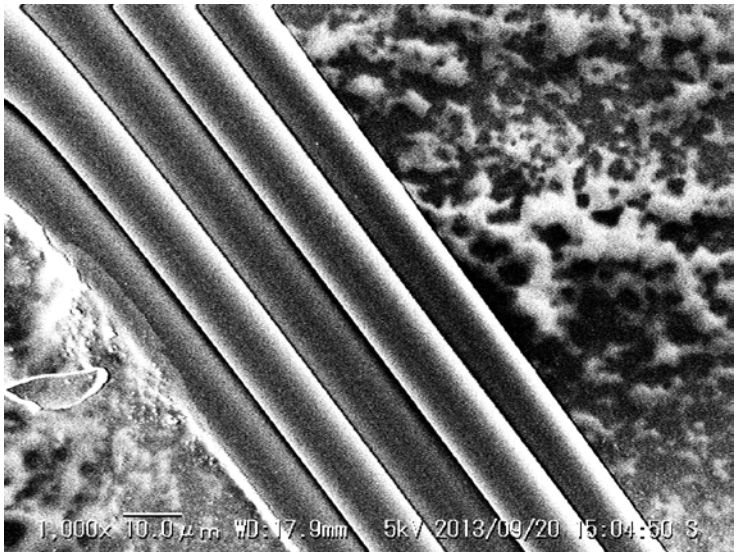
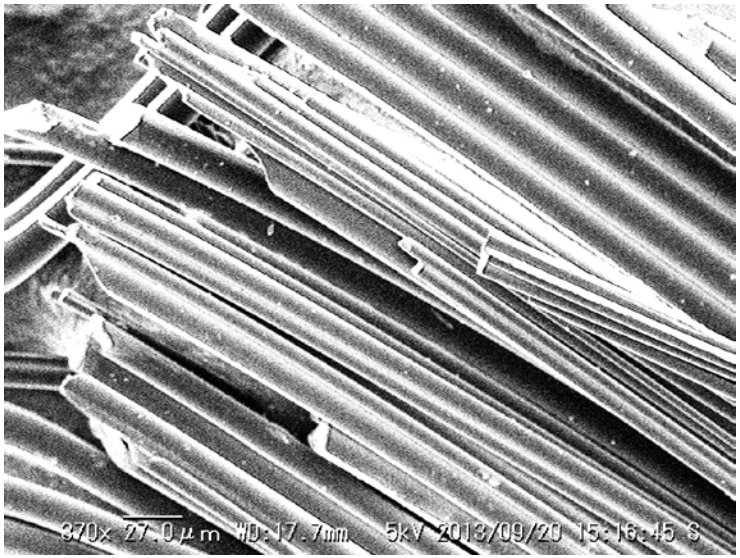
Preparation of carbon fiber from Soluble

Carbon fiber from RS Soluble









10μm

Carbon fiber was successfully prepared from Soluble

Summary

- Degradative Solvent Extraction method can dewater and upgrade brown coal without losing heating value with a mild condition.
- Solubles from different biomass samples show similar elemental compositions.
- Solubles are rich in C and H. (soften and completely melts below 100 °C.)
- Our SATREPS targets the implementation of this technology for utilizing low rank coals and biomass wastes in Thailand.
- In JASTIP we hope to extend this method to

SATREPS extension

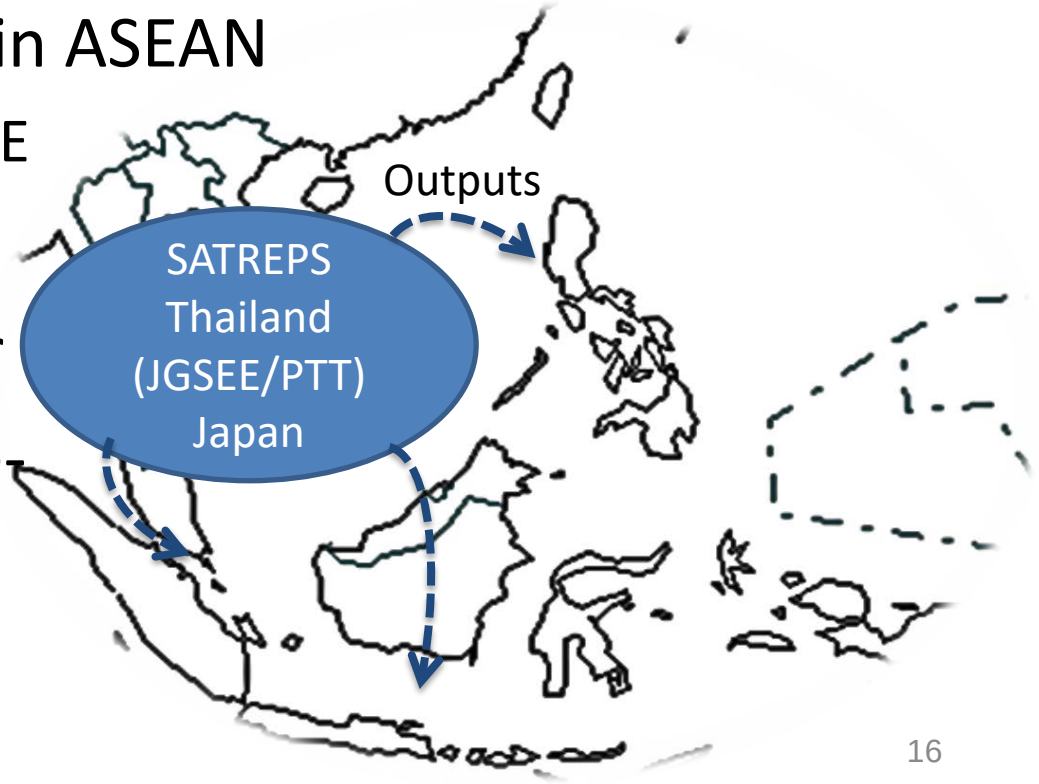
Extension of “Solvent Treatment Method” developed by SATREPS program to ASEAN region

– Basic study on possibility for application of biomass resources in ASEAN
  - Satellite lab in JGSEE

If possible,

– technology transfer

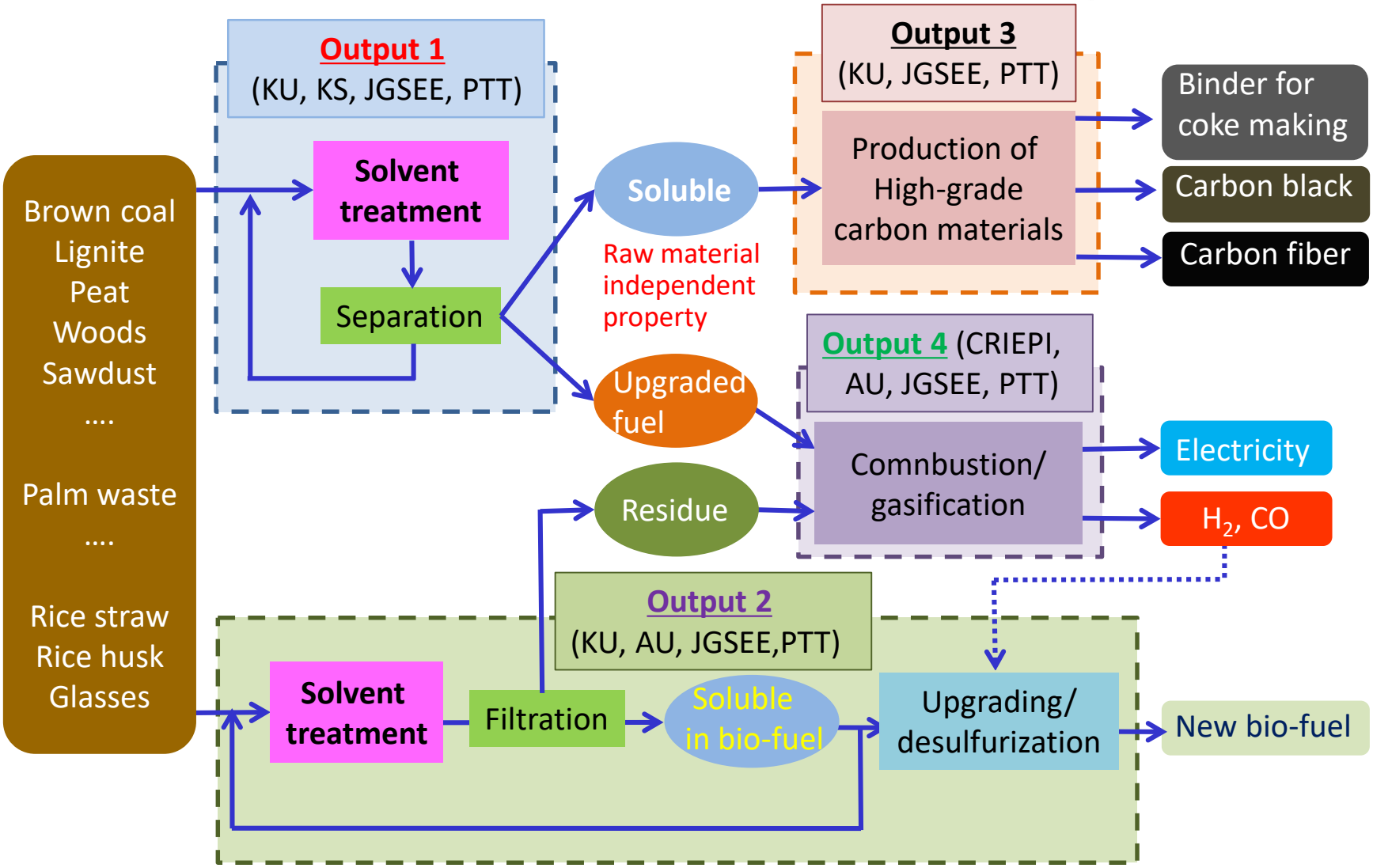
– promotion of imple-mentation in other Countries (budget!!)



ขอบคุณครับ

thank you

Structure of Research and Development



Output 1: Upgrading of low rank coals and biomass by solvent treatment
Output 2: Production of new bio-fuel from biomass wastes and effective upgrading
Output 3: Production of high-grade carbon materials from the Solubles
Output 4: Combustion/gasification of upgraded fuels/residues