Interfacial Phenomena in the Processes of Biodiesel Productions from Sunflower Oil and Waste Cooking Oil In Alkaline Methanol Phase

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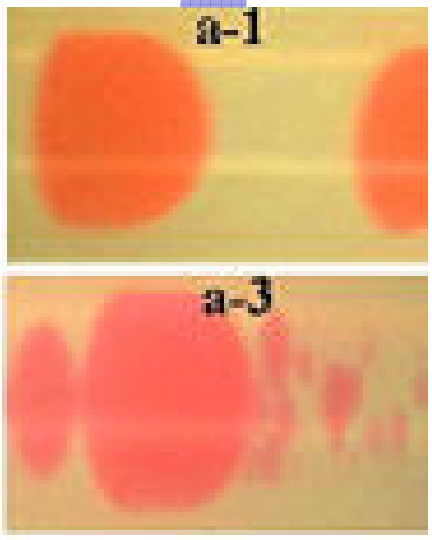
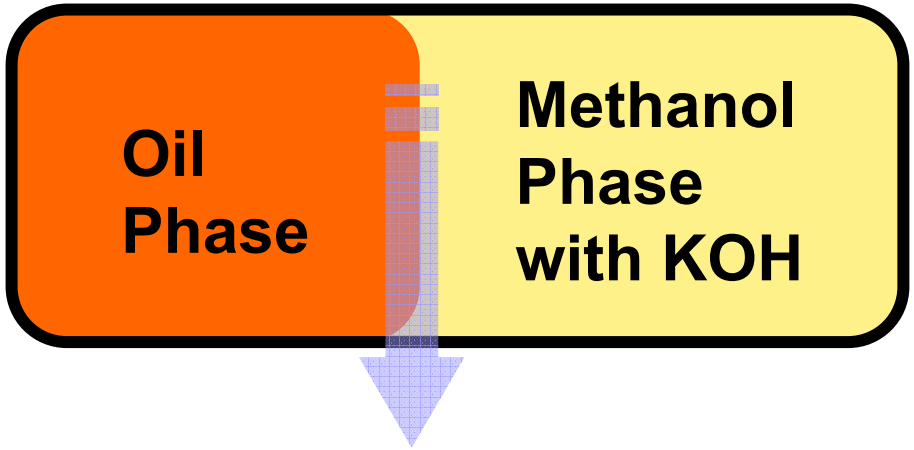
World Congress on Oils and Fats & 28th ISF Congress

09.2009 Sydney Australia

Typical reaction of biodiesel production

The transesterification of oil with methanol to produce biodiesel fuels (BDF) is a typical two-phase reaction.





$$TG + CH_3OH \rightleftarrows FAME + DG$$

$$DG + CH_3OH \rightleftarrows FAME + MG$$

$$MG + CH_3OH \rightleftarrows FAME + GL$$

Motivations of interfacial study

1. **The reaction takes place at the interface.**

2. **The distribution or adsorption of chemical species at the interface has a great influence on the reaction.**

3. **The change of the interfacial properties such as interfacial tension has an influence on the emulsification process and then the reaction rate.**

4. **The fatty acid and side-product such as monoglyceride are surface active materials and then the reaction can be influenced by the adsorption phenomena.**

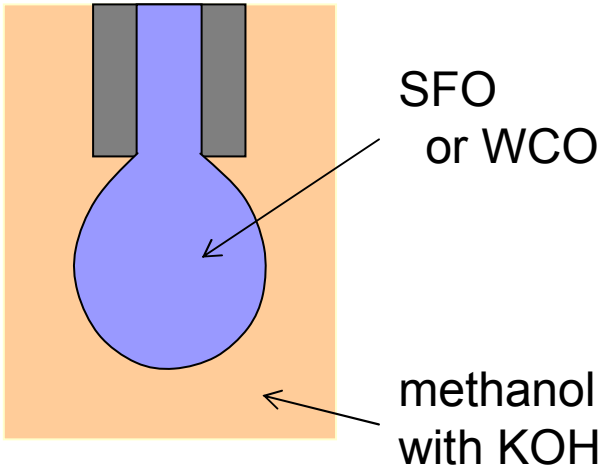
Experimental

The interfacial reaction was investigated by observing a single pendant drop of oil in methanol phase.

Systems:

Sunflower oil (SFO) /
methanol with KOH system

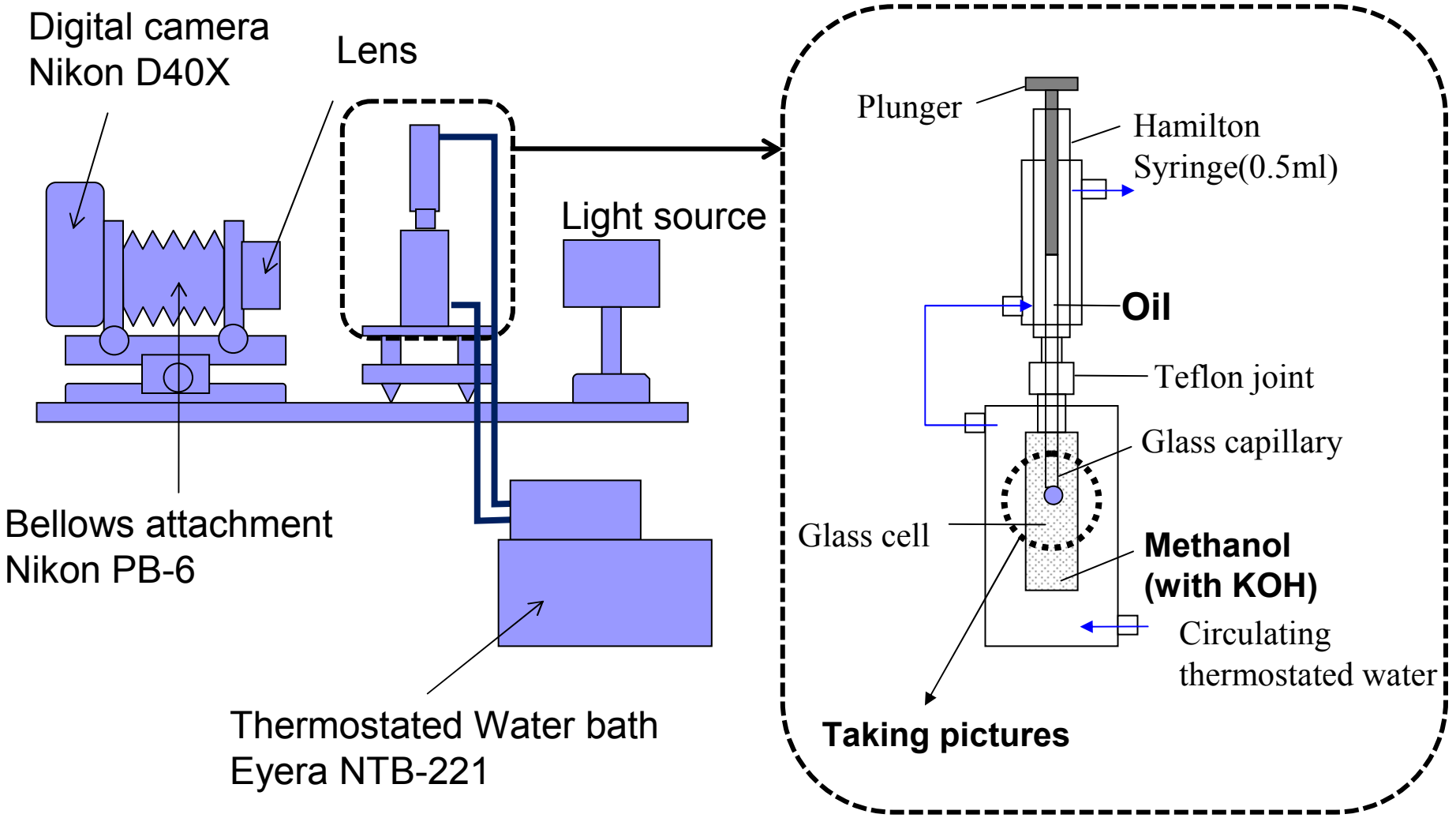
Waste cooking oil (WCO) /
methanol with KOH system



Conditions:

concentration of KOH : 0 % or 4.5 %
temperature : 298.15 K
pressure : atmospheric pressure
size of glass capillary : 0.9 mm (inner diameter)

Set up for measurement

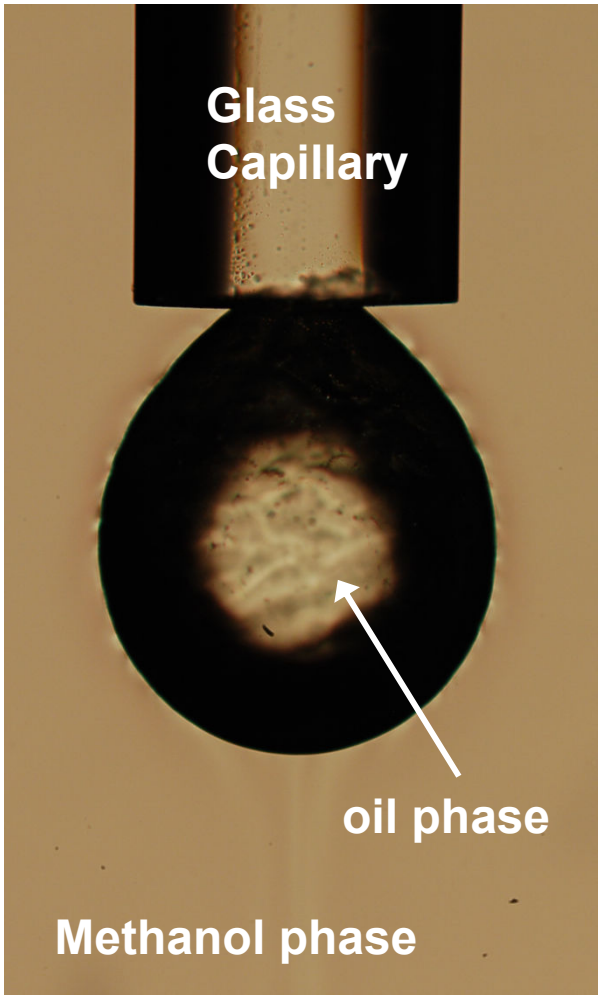


Analysis

1. Observation of the pendant drop
of oil in the methanol phase
↓
Mechanism of interfacial reaction

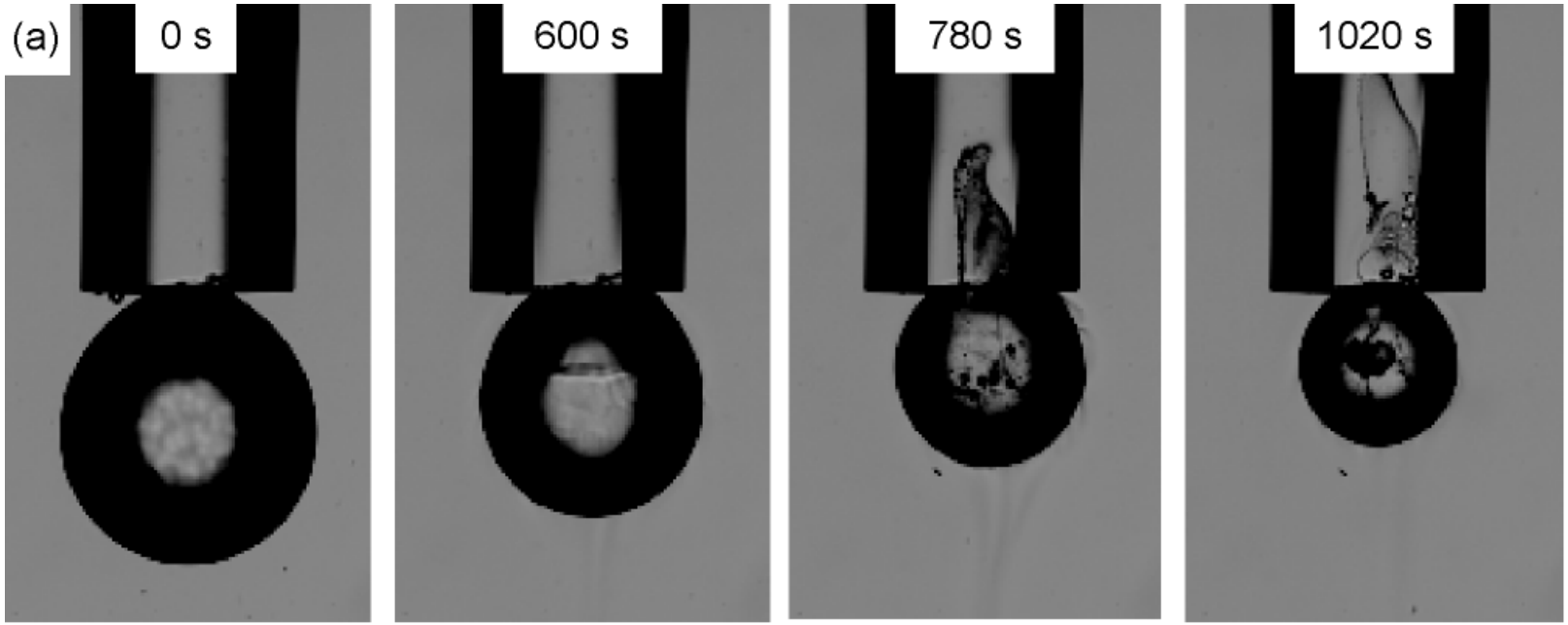
2. Measuring the size change
of the pendant drop
↓
Change of reaction rate

3. Measuring the interfacial tension
by the shape analysis of drop
↓
Change of the interfacial property



Change of pendant drop due to the reaction

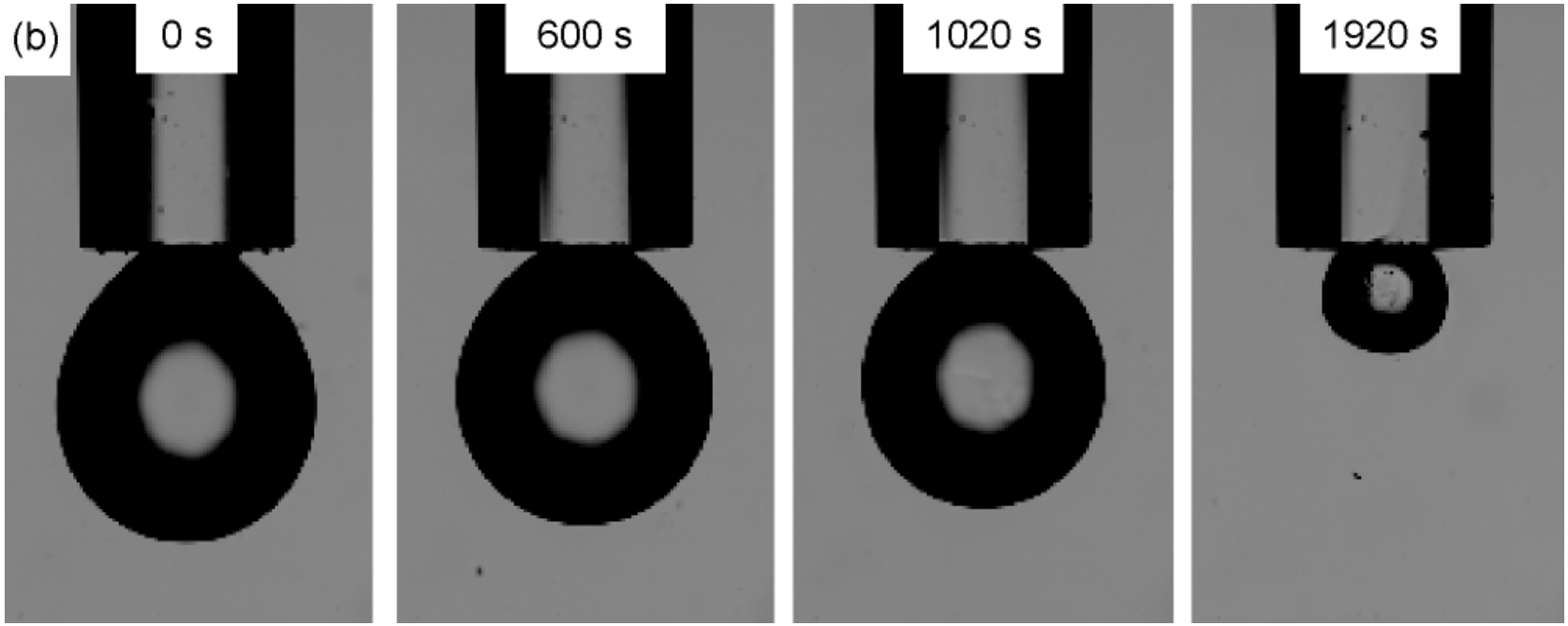
(SFO / methanol with 4.5 % KOH)



- The size of drop constantly decreased.
- Flow pattern due to the reaction was observed.
- Small droplets was formed in the pendant drop during the reaction.

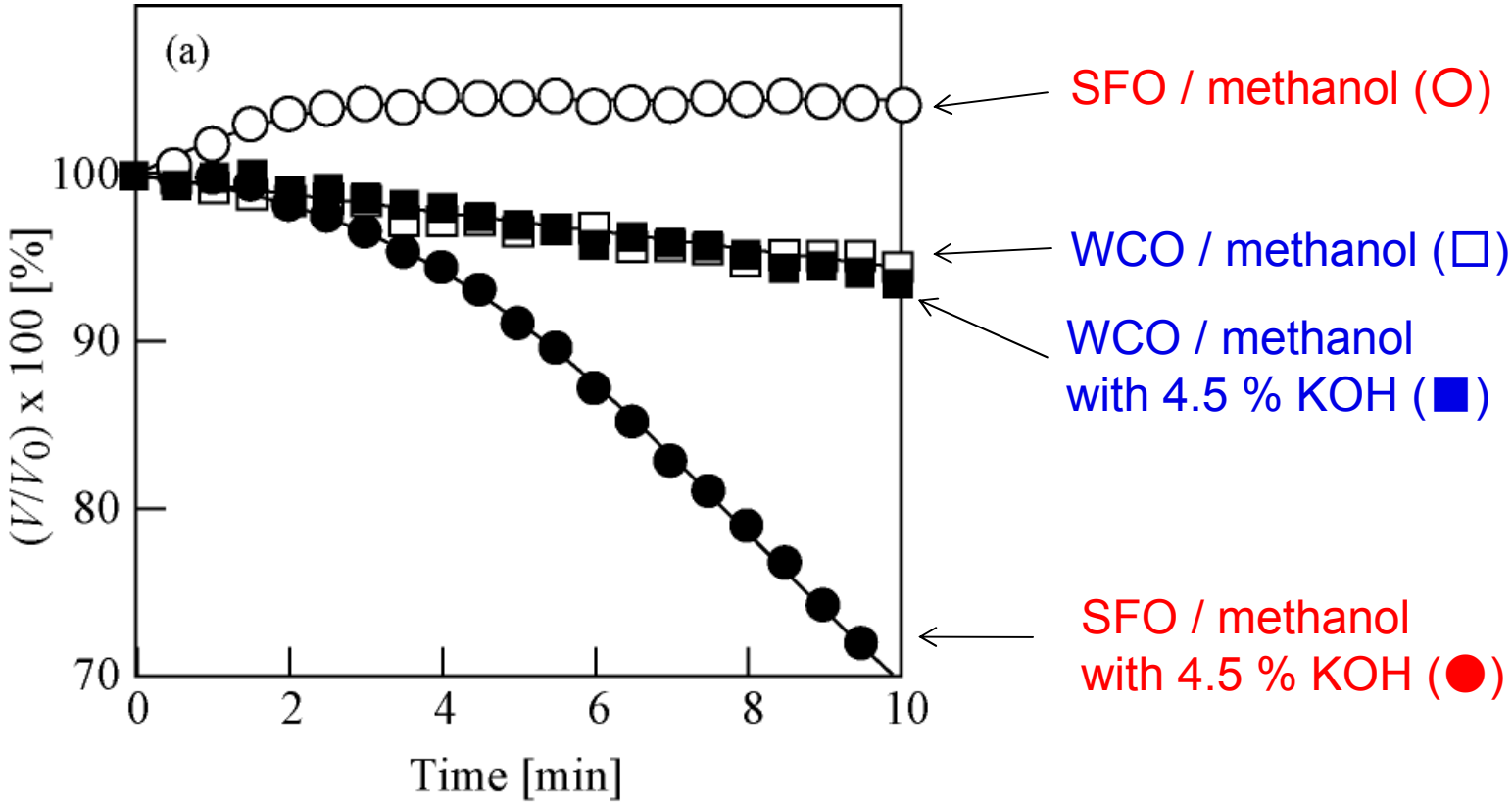
Change of pendant drop due to the reaction

(WCO / methanol with 4.5 % KOH)



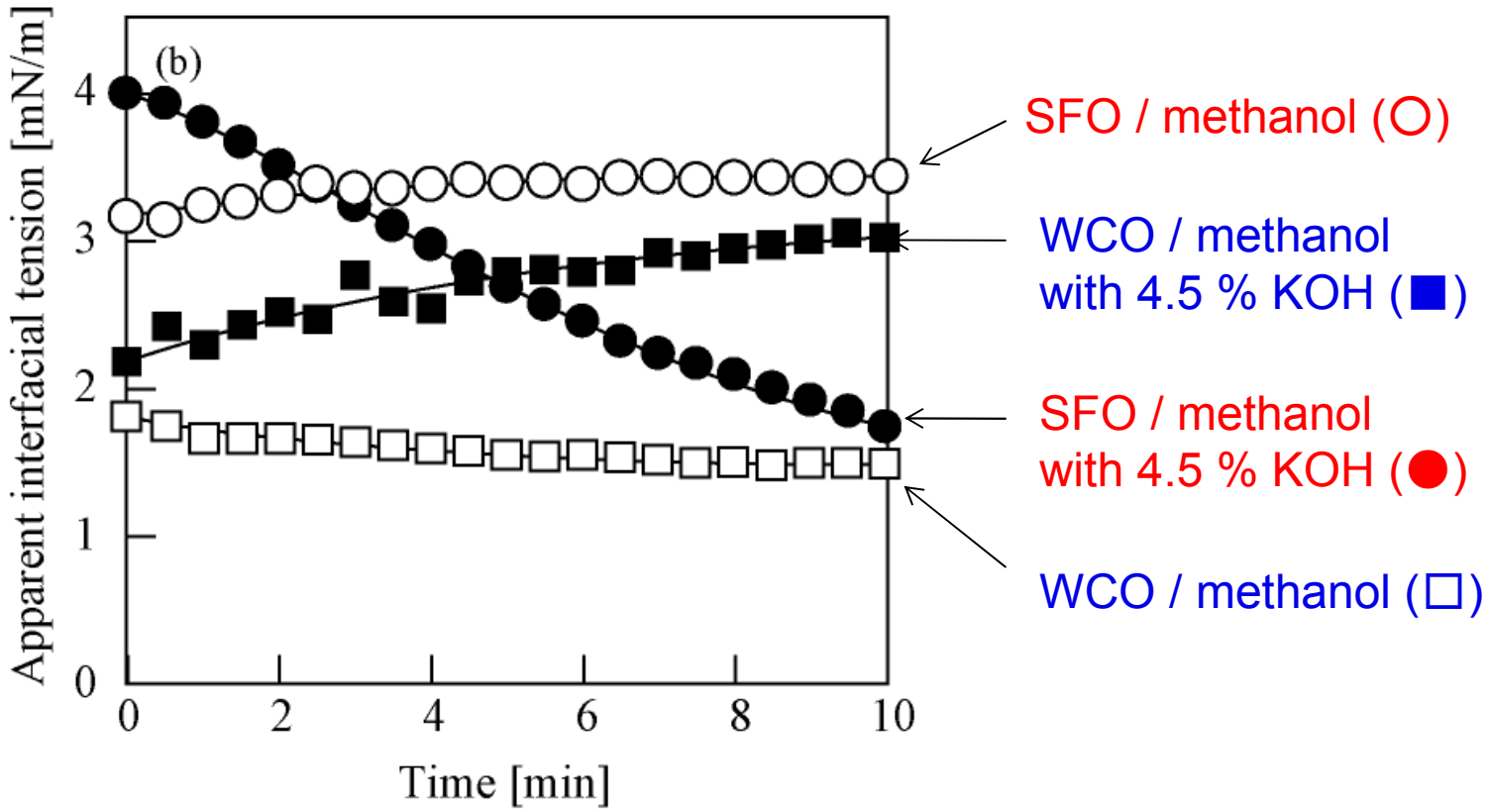
- The size of drop decreased with lower speed.
- Flow pattern due to the reaction was observed after some time.
- Small droplets was not formed apparently.

Change of drop volume due to the reaction during the first 600 s



- The drop size of SFO (KOH, 4.5%) constantly decreased due to the diffusion of product FAME in methanol.
- The drop size of WCO slightly decreased regardless of the existence of KOH due to the diffusion of FFA and water in methanol.

Change of apparent interfacial tension (γ^{ap}) during the first 600 s



- The γ^{ap} of SFO (KOH, 4.5%) decreased due to the surface active products (FAME, MG, DG).
- The γ^{ap} of WCO (KOH, 4.5%) increased. This suggests that the product from the reaction of FFA changes the interfacial properties.

Conclusions

1. The different morphology of interfacial reaction has been observed in the FAME production process between SFO and WCO systems.

2. The initial reaction rate of WCO, compared with that of SFO, is decreased due to the contaminations such as FFA and water.

3. The change of apparent interfacial tension also shows a different tendency between SFO and WCO systems. This suggests that the interfacial diffusions of chemical species for the production of FAME are disturbed by the reaction of FFA and water with KOH.