

Investigation of Controlling PCCI Combustion Process in Consideration of Heterogeneity of Mixture

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Background and purpose

• Extend the operating range of PCCI combustion

Variety approaches...

(1) Distribution of air-fuel mixture concentration

- Norimasa Iida *et al.*

Keio university

JSME B, Vol. 71, No.701, pp295-302, 2005.

(2) Fuel ignitability

- Magnus Sjöberg *et al.*

Sandia National Laboratories

SAE2006-01-0629

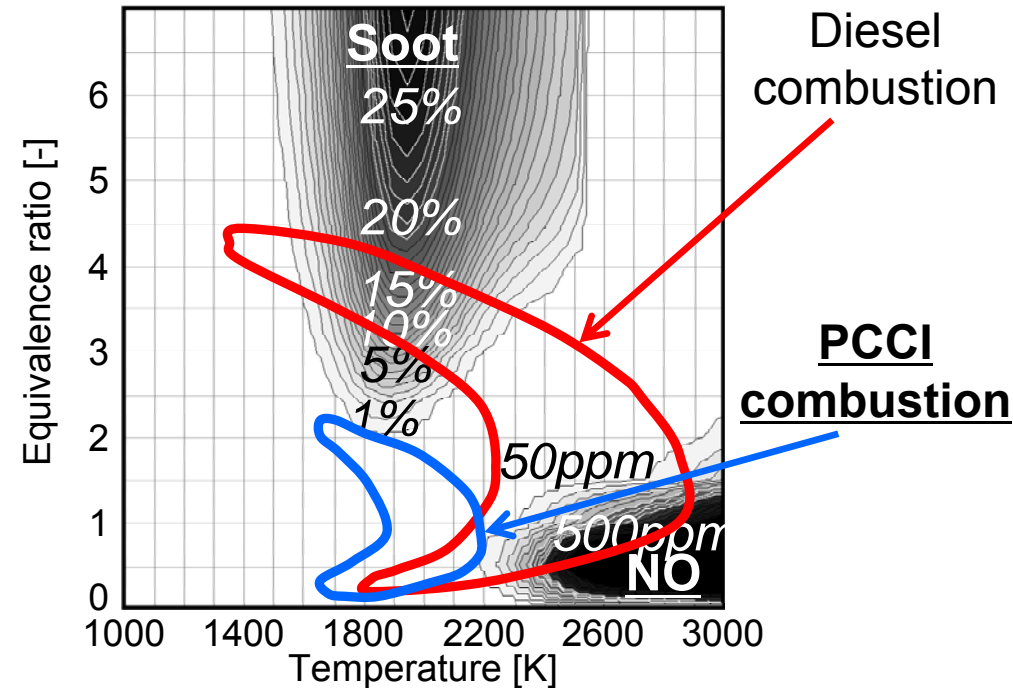
(3) Fuel properties

- Gen Shibata *et al.*

Nippon Oil Corporation

SAE2008-01-0007

(4) EGR (Exhaust Gas Recirculation)



(Ref. Kitamura, T et al., 2002)

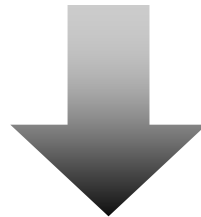
Background and purpose

Necessity for evaluation of fuel potential...

In this study

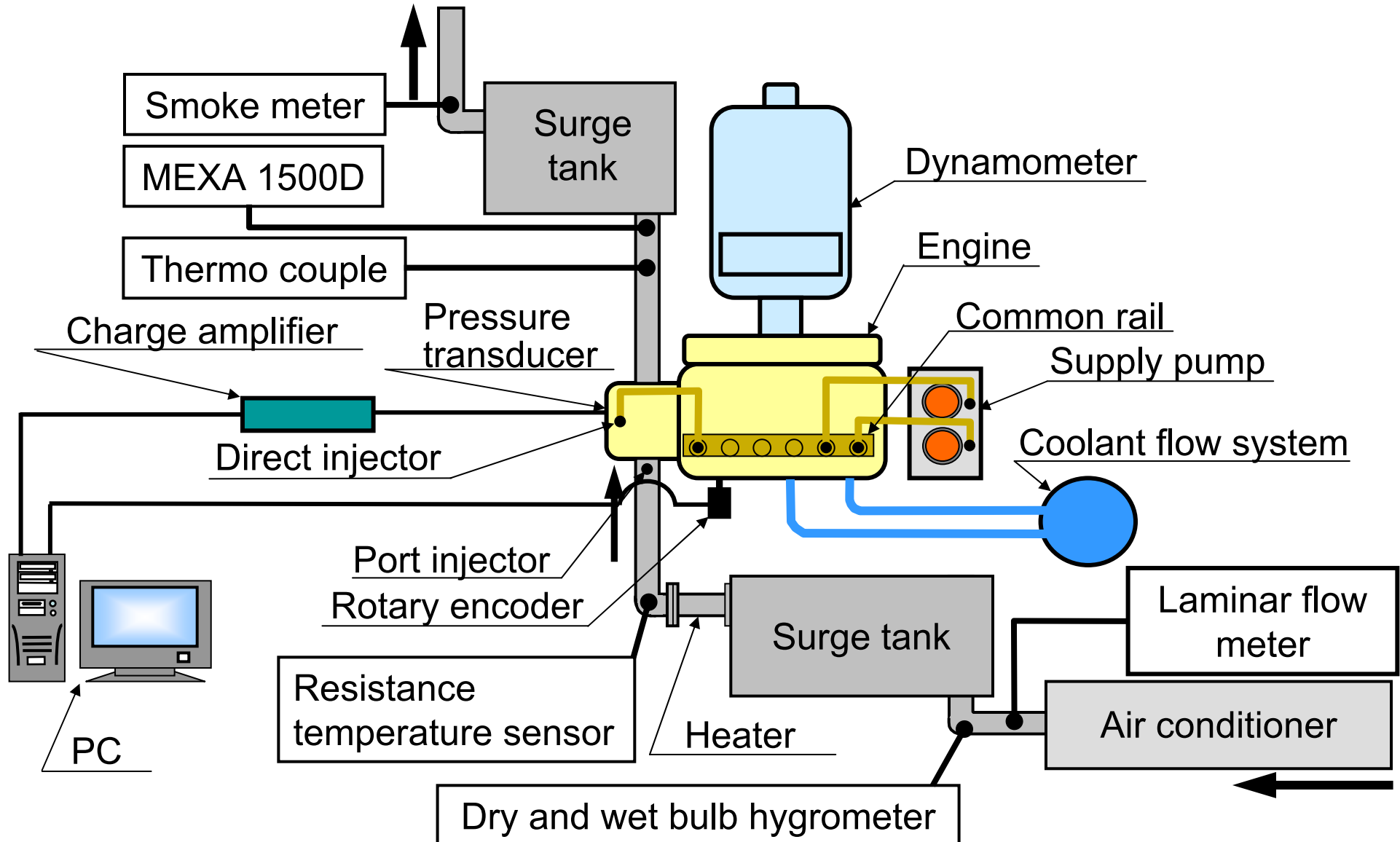
Focus on

- **Fuel ignitability**
- **Heterogeneity of fuel concentration**



Controlling PCCI combustion

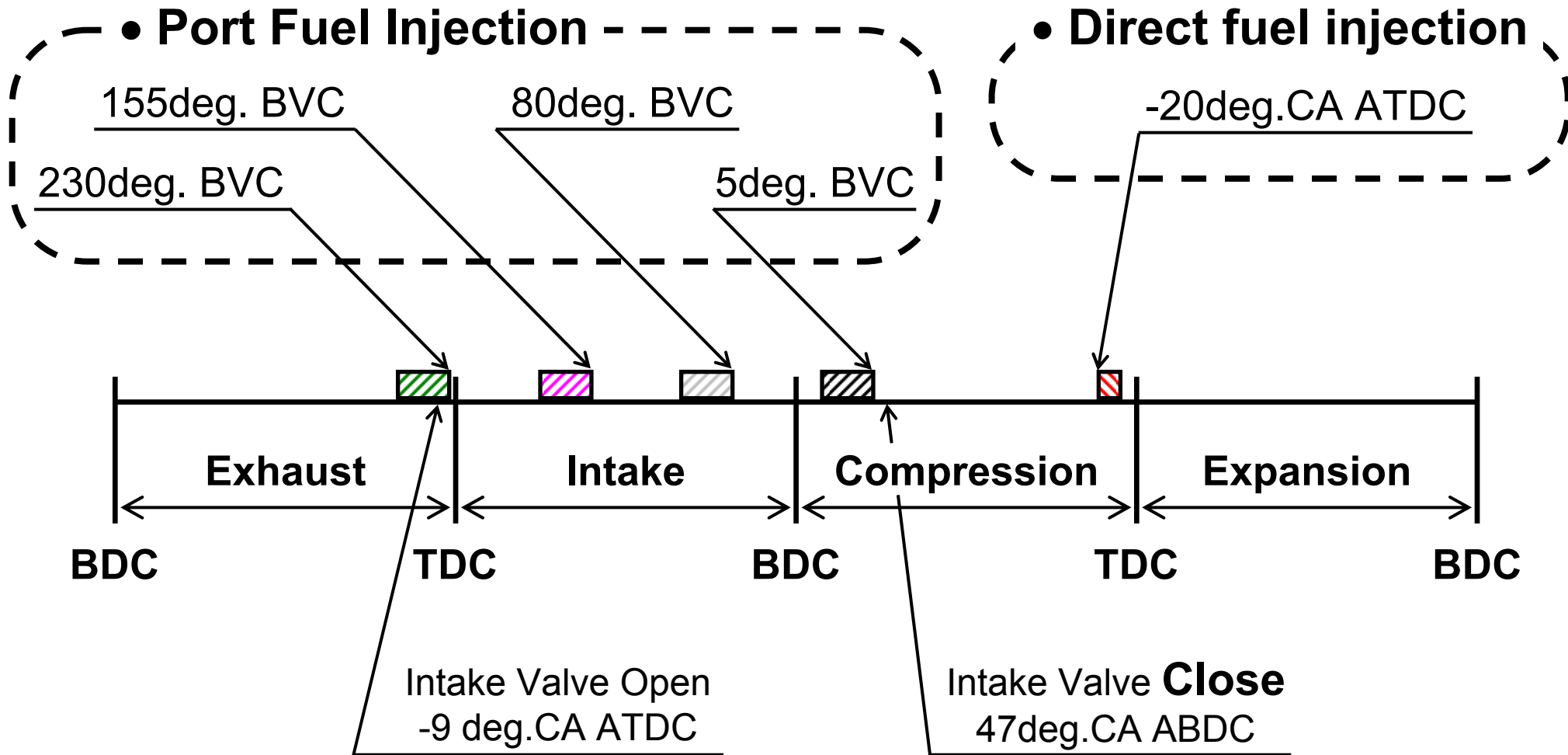
Schematic diagram of test engine system



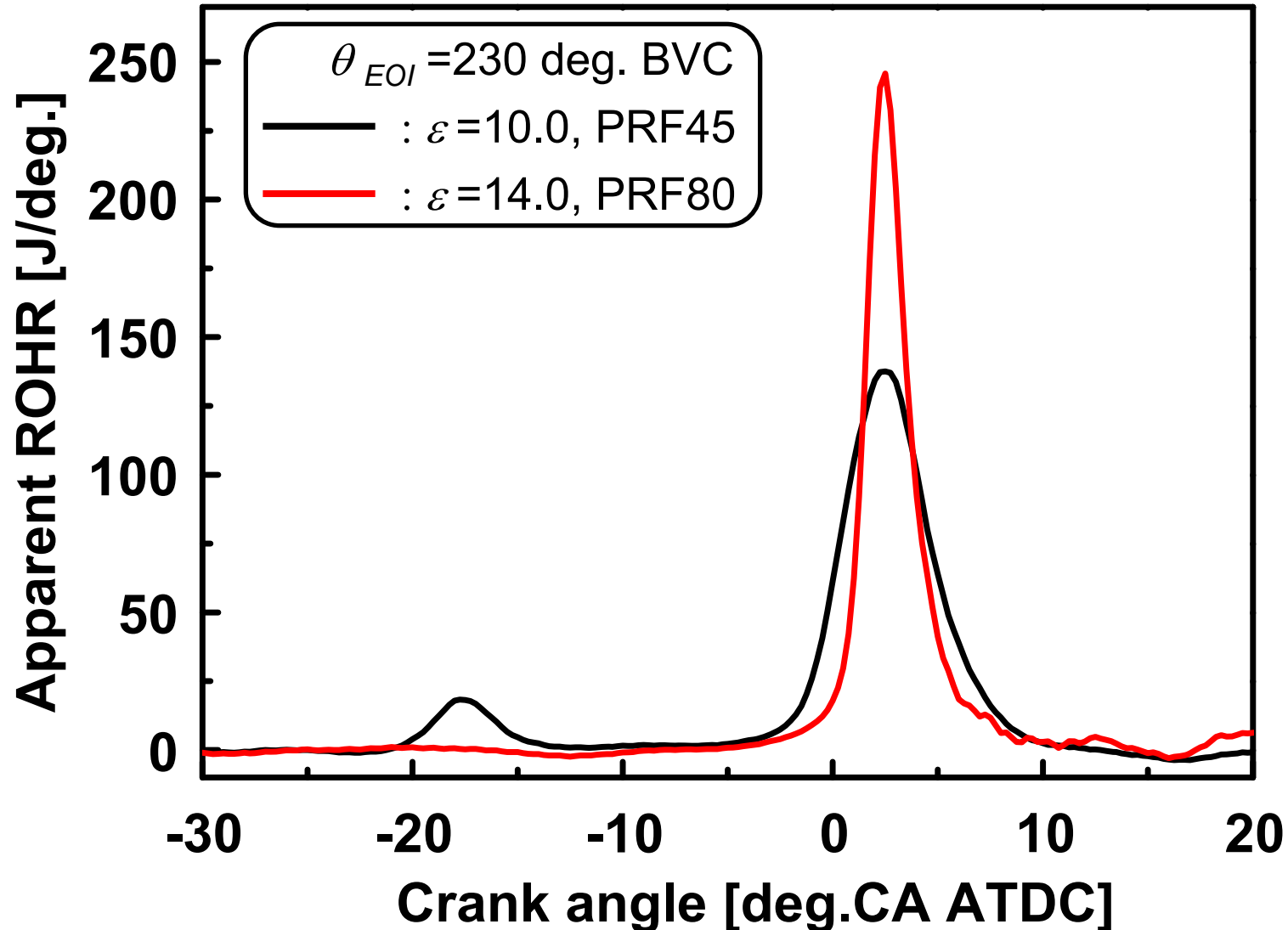
Experimental conditions for actual engine

Engine type	DI Diesel, single cylinder, water cooled 4 stroke cycle, 2 valves	
Bore×Stroke [mm]	$\phi 110 \times 106$	
Combustion chamber shape	Dish	
Engine speed [rpm]	1200	
Test fuel	PRF45($\varepsilon=10.0$)	PRF80($\varepsilon=14.0$)
Nozzle configuration	straight, 12holes (PFI)	
	$\phi 0.14 \times 8$, included spray angle 100deg (DI)	
Injection pressure [MPa]	0.3(PFI) □ 40(DI)	
Port injection timing [deg.BVC]	5, 80, 155, 230	
Direct injection timing [deg.CA ATDC]	-20	
Total equivalence ratio ϕ_{all} [-]	0.38	
Injection quantity ratio PFI:DI [-]	10:0 □ 9:1, 8:2, 7:3, 6:4, 5:5	

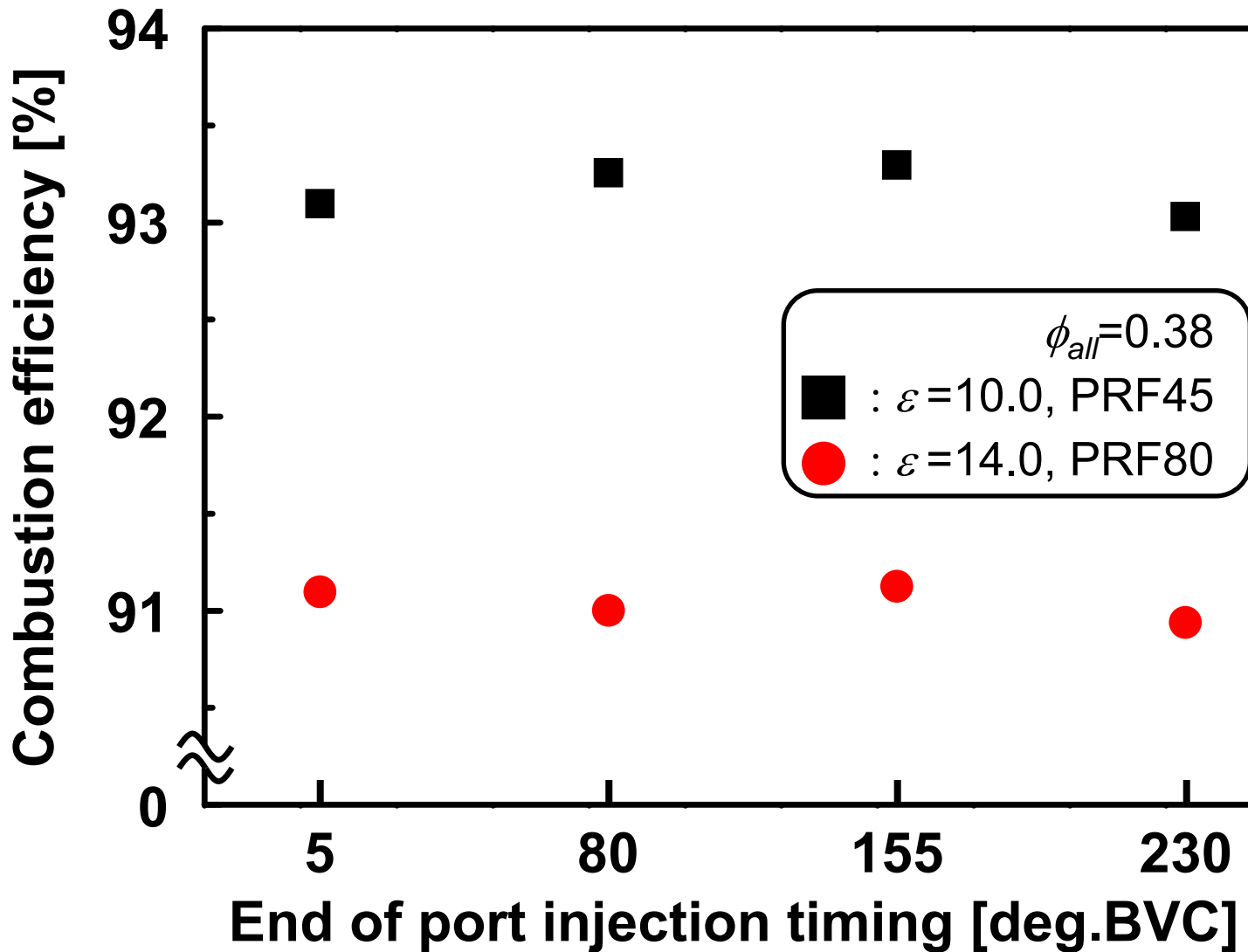
Timing chart of port and direct fuel injection timing



Effect of fuel ignitability on ROHR

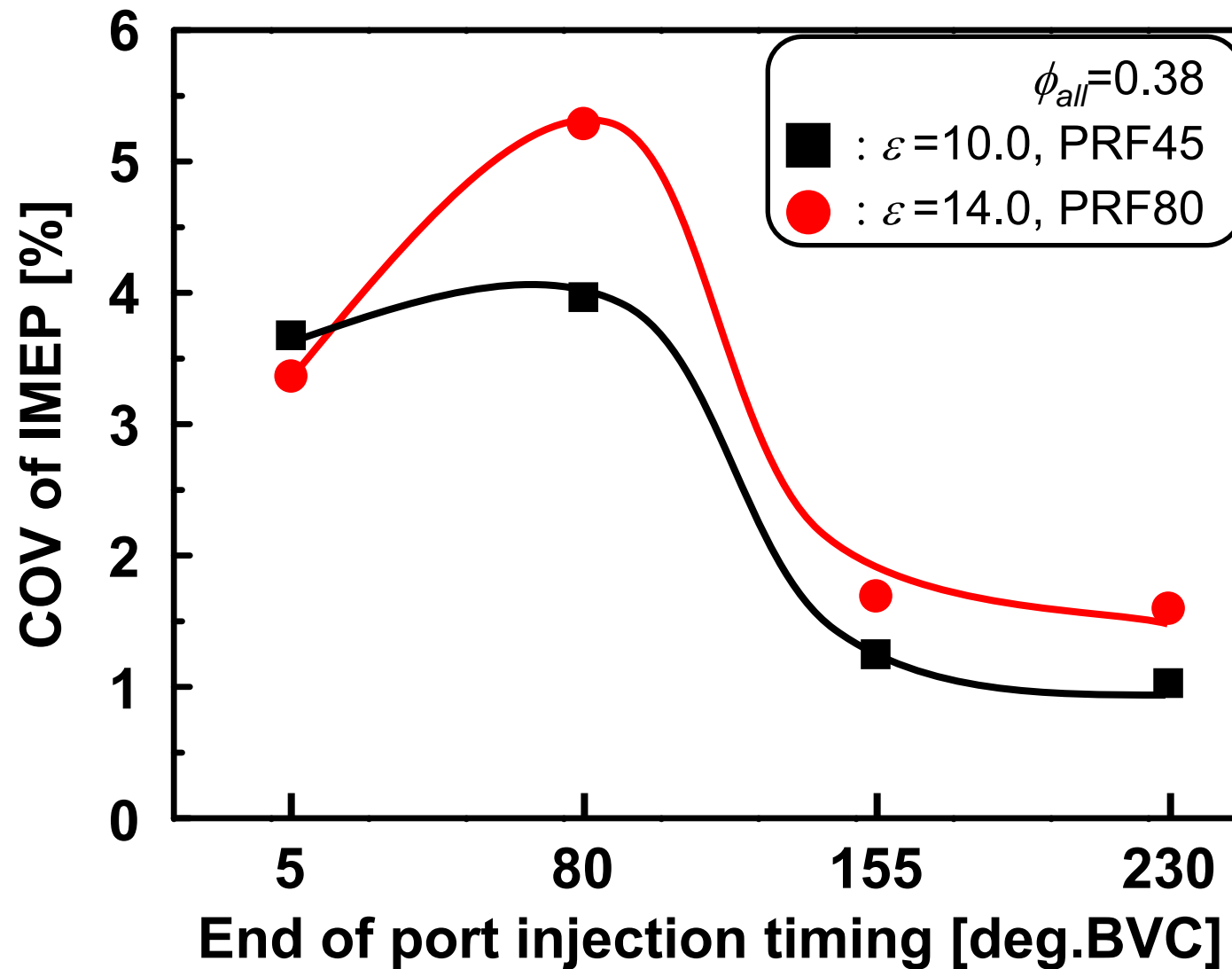


Effect of port fuel injection timing on combustion efficiency

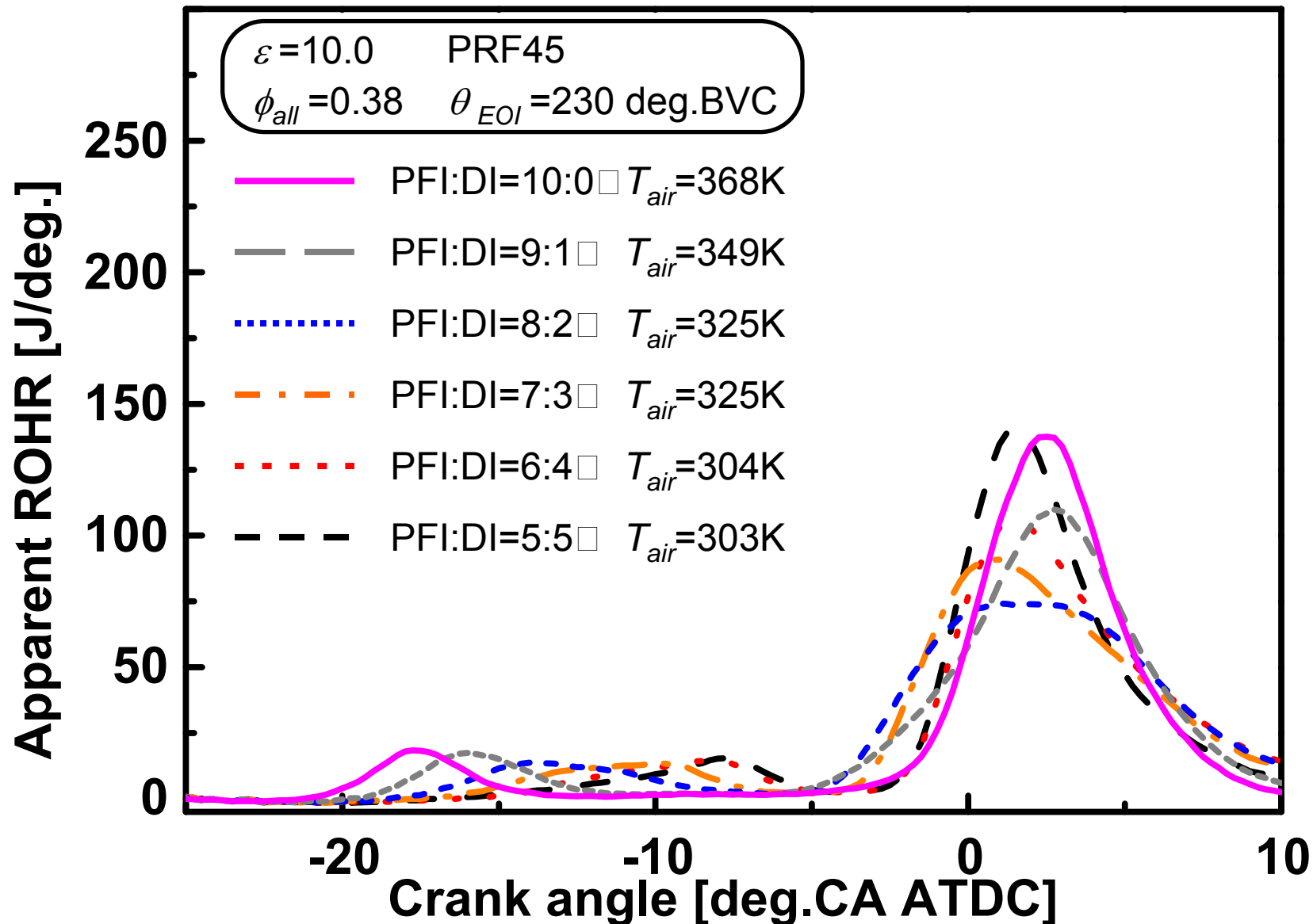


Effect of port fuel injection timing and fuel ignitability on coefficient of variation of IMEP

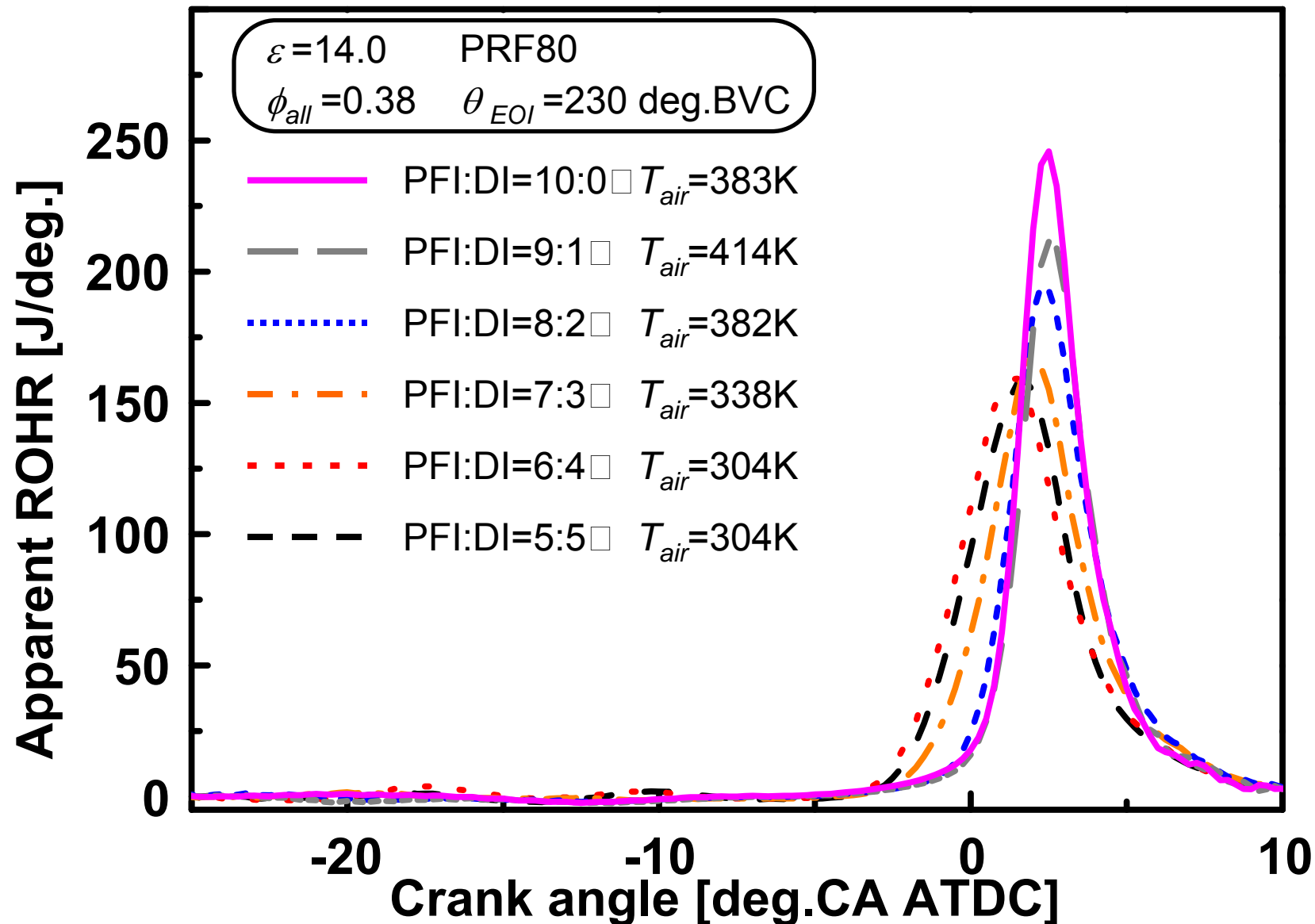
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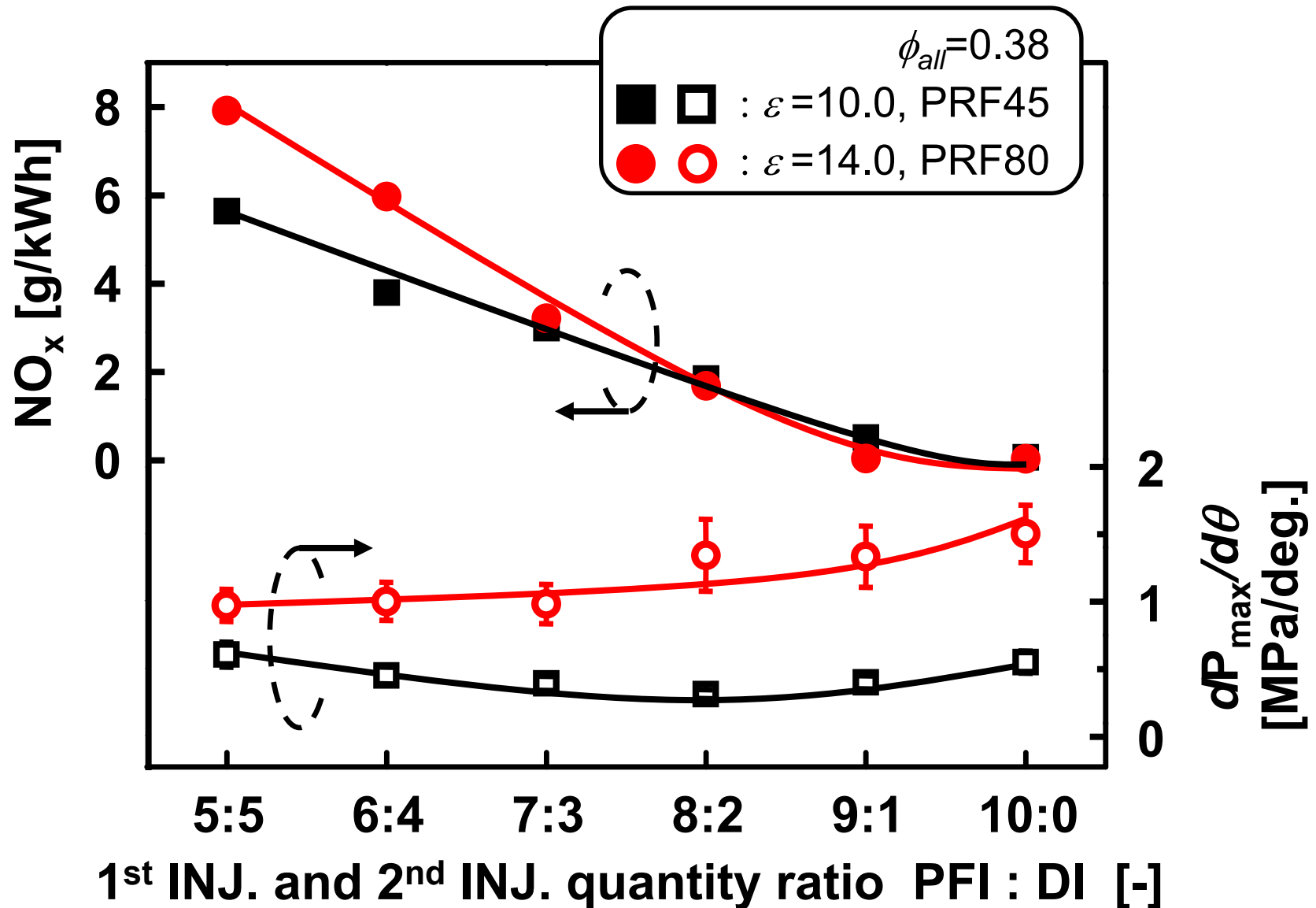
Effect of fuel injection quantity ratios on ROHR ($\varepsilon=10.0$ □ PRF45)



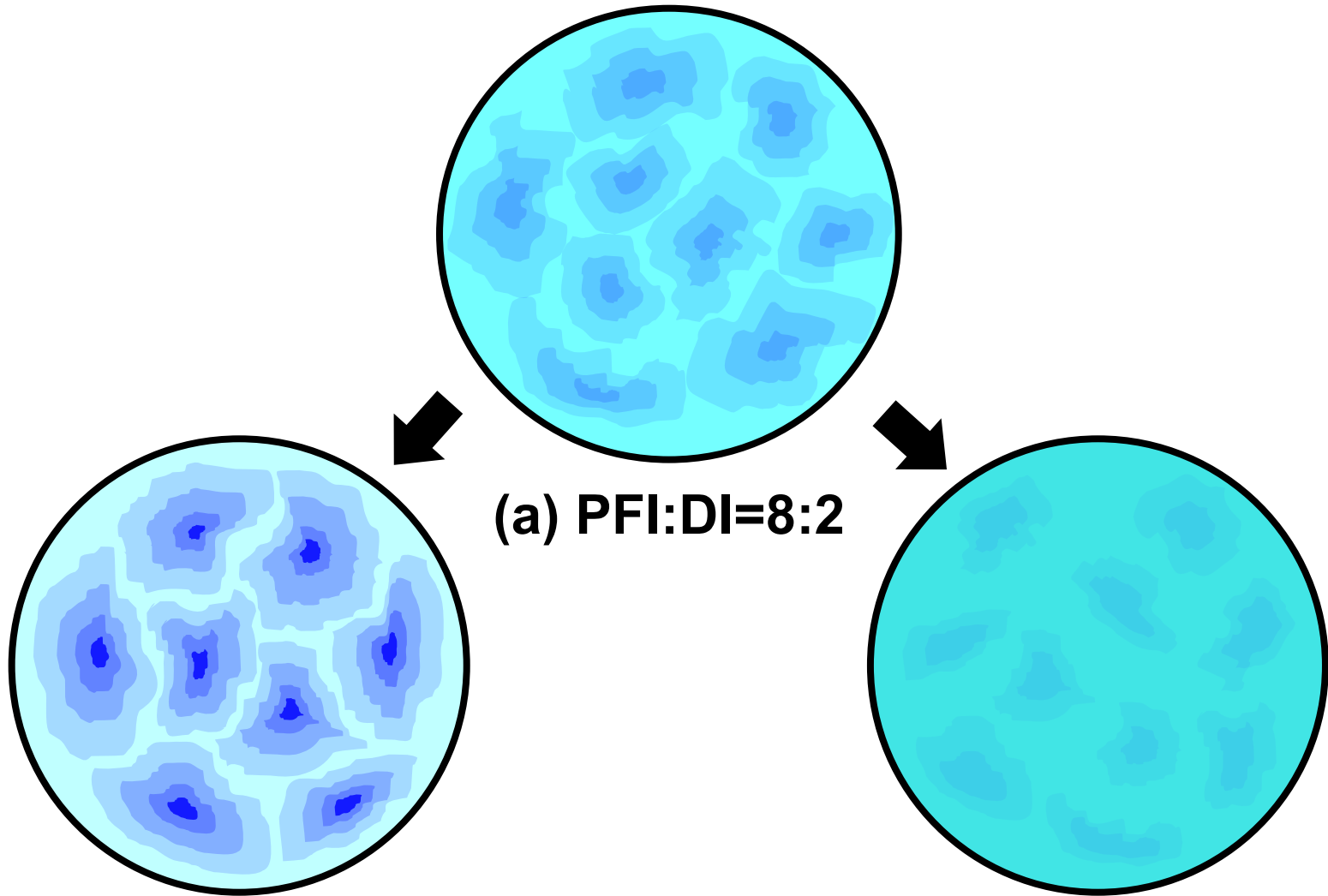
Effect of fuel injection quantity ratios on ROHR ($\varepsilon=14.0$ □ PRF80)



Comparison of changes in maximum rate of pressure rise and NO_x emissions between PRFs



Conceptual diagrams of heterogeneous mixture



Summary

- The lower octane fuel has much heat release of LTHR, so it become a high combustion efficiency.
- The emission of NO_x originates in the rich air-fuel mixture which is formed by direct fuel injection.
- Having a LTHR fuel has a great advantage in low rate of pressure rise and NO_x emissions
- The heterogeneity of the mixture formed by the two-stage fuel injection has the effect which makes sluggish or steep combustion process. And the optimal air-fuel mixture is different according to fuel ignitability.