Decarburization behavior in steel sheet for hot stamping

Retardation of decarburization at higher temperatures

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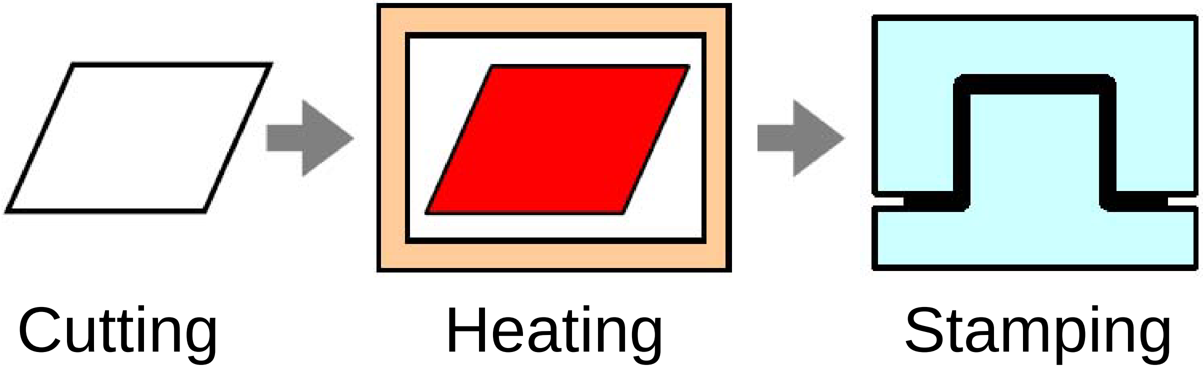
Background

- Hot stamping

  Automotive parts with tensile strength of 1500 MPa



- Heating conditions

  Ambient or gas atmosphere (Oxidation atmosphere)

  Austenitic temperature (High temperature)

  ⬇

  Decarburization conditions

Experimental Procedure

- Sheet steel

  Thickness: 1.6mm

  Chemical composition in mass% and A_{e3} of steel :

C	Mn	Others	A_{e3}
0.21	1.2	Si, B, Ti, Cr	1073K

- Heating conditions

  Rapid heating

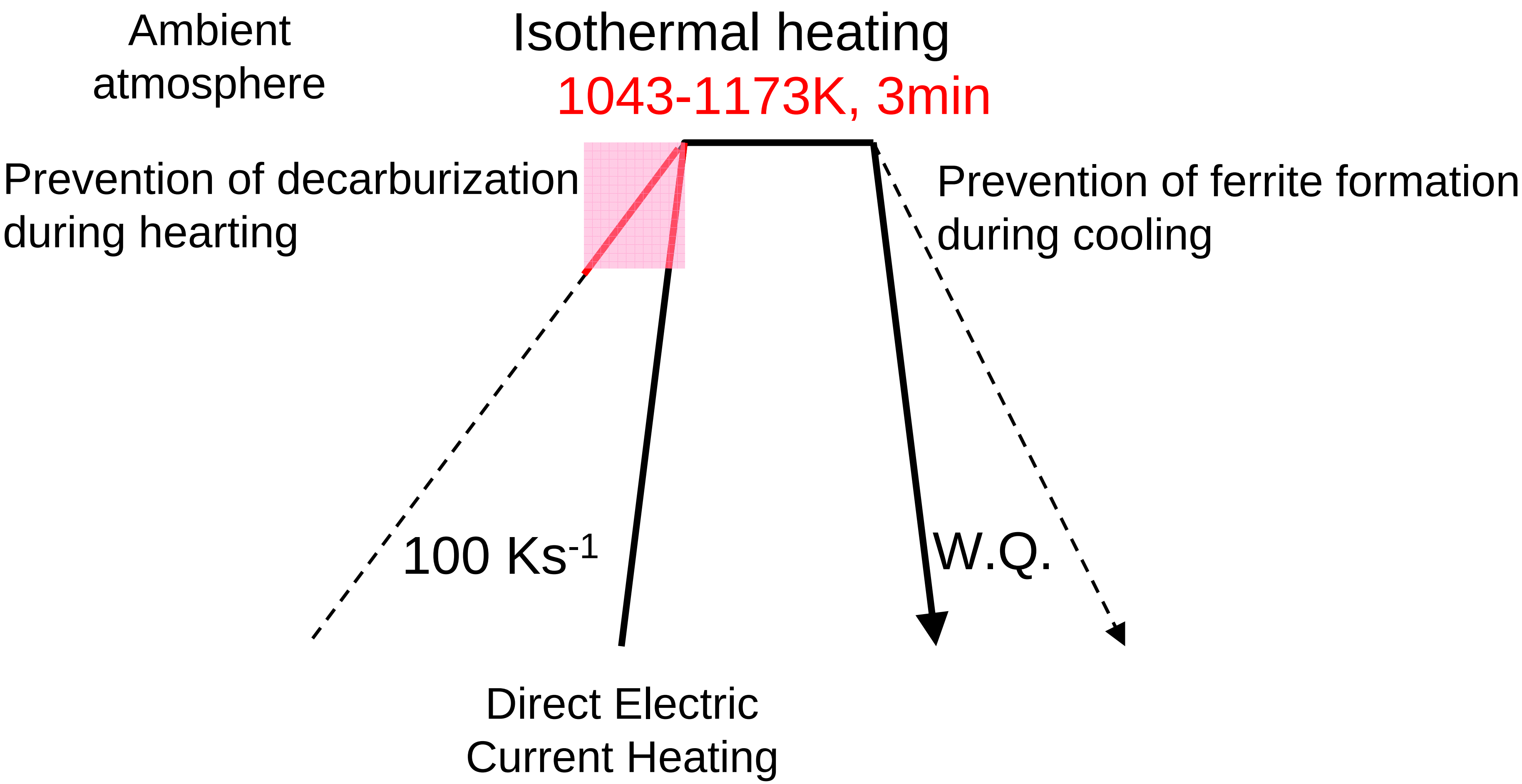
  Water quenching

- Microstructure observation

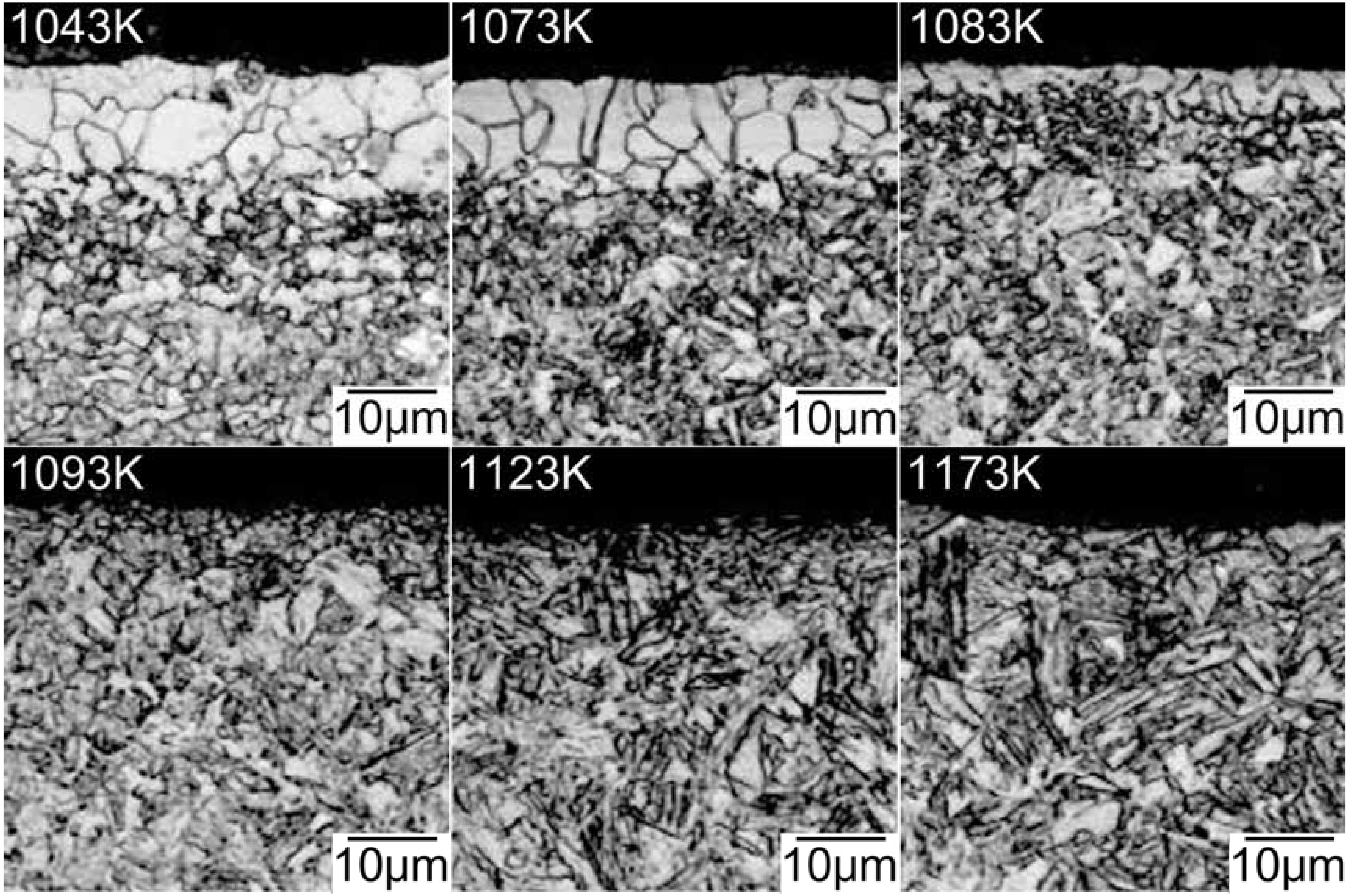
  Laser microscope

Heating Conditions

Rapid heating & Water quenching

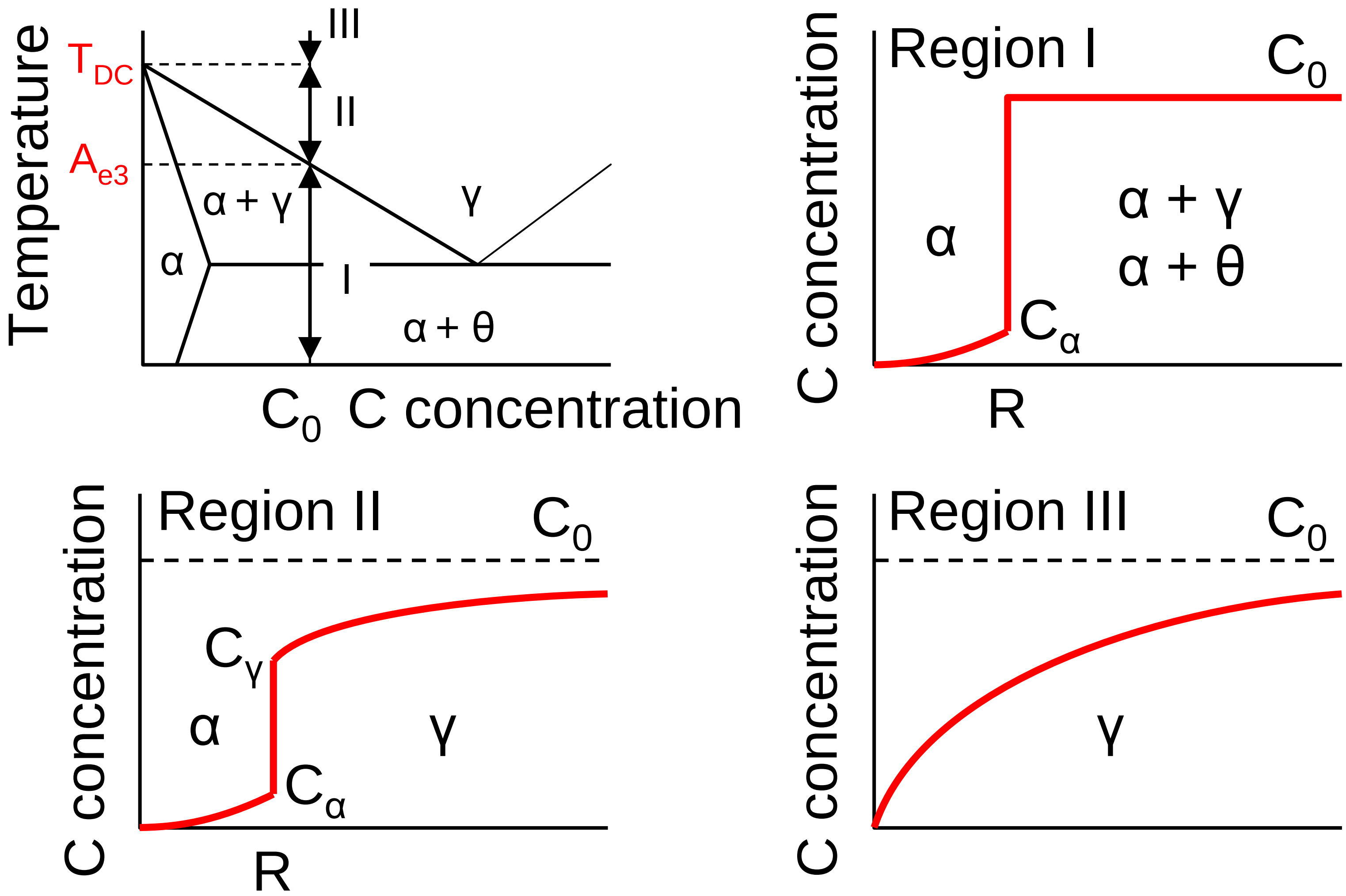


Microstructure



Decarburization Model

Birks and Jackson (1970)

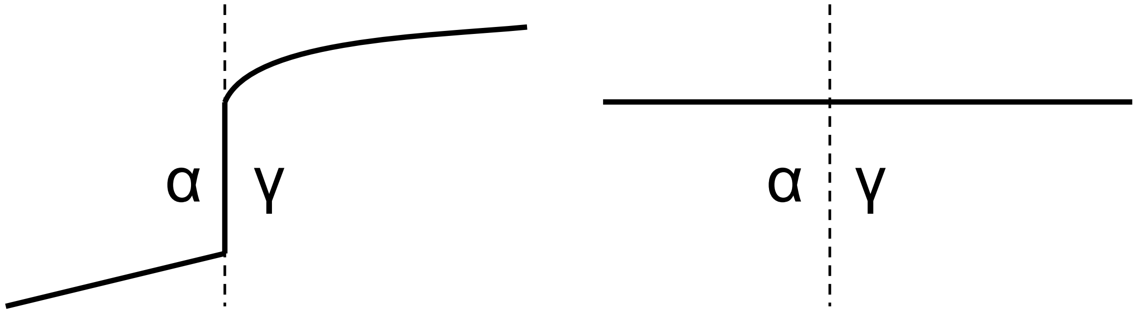


Partition of alloying elements

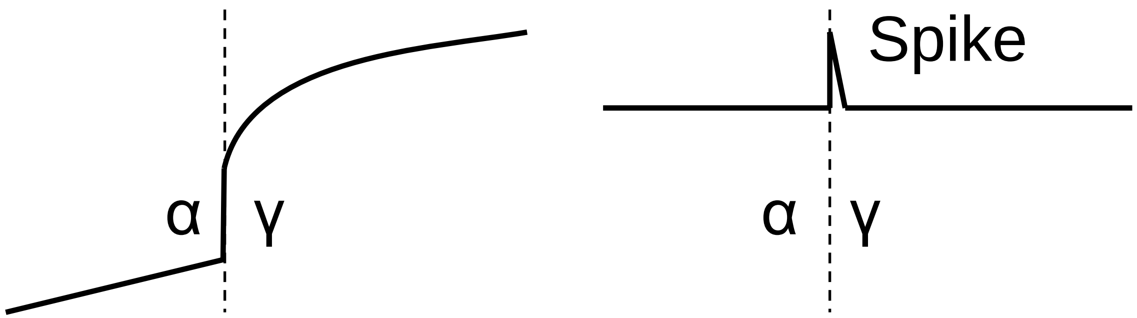
Phillion(2004)
Hutchinson(2004)
Beche(2007)
Zurob(2008)

	Interstitial element C profile	Substitutional element Mn profile

Para Equilibrium (PE)



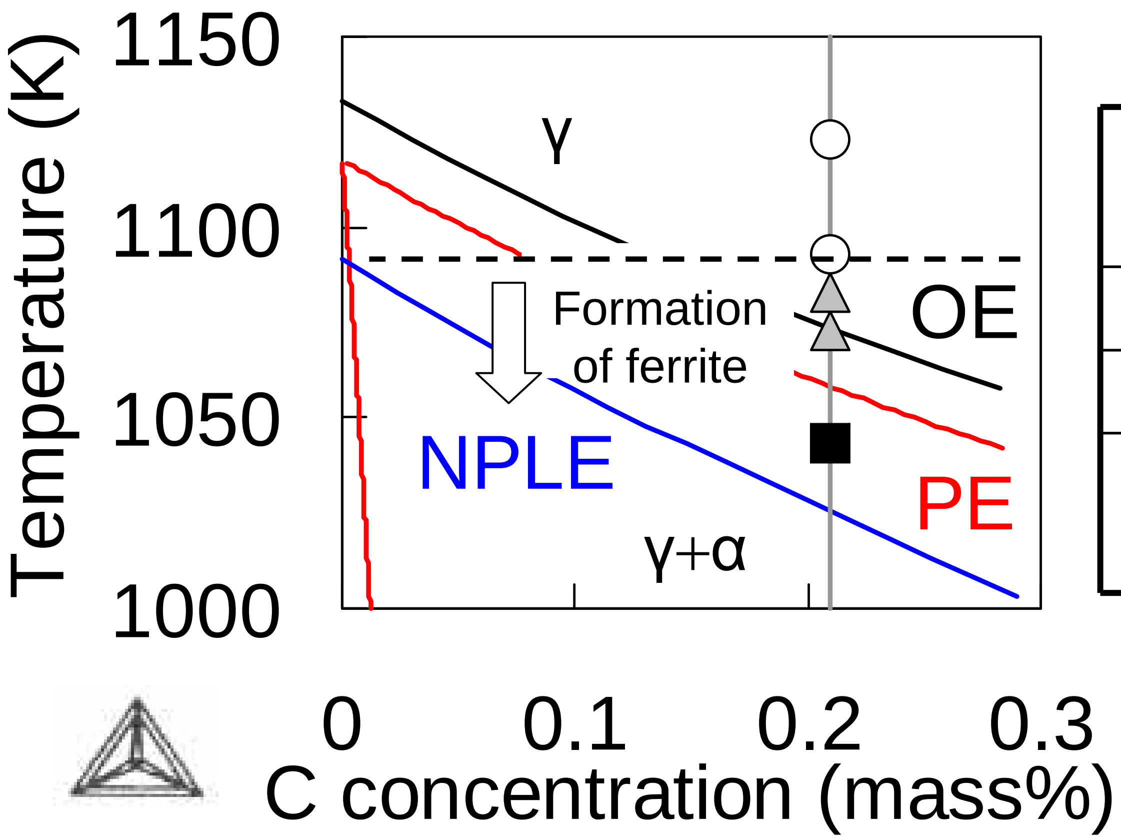
No Partition Local Equilibrium (NPLE)



α/γ interface　　α/γ interface

Phase diagram and Microstructure

Fe-C-1.2Mn



Isothermal heating

	Surface region	Inside region
○	Martensite	Martensite
▲	Ferrite	Martensite
■	Ferrite	F+M Dual-phase

Conclusions

Fe–0.21C–1.2Mn, *T* = 1043–1173K, *t* = 180s

- Formation of ferrite on surface due to decarburization

  T = 1043–1083K

- Growth rate of ferrite: v

  $v_{1043K} > v_{1083K}$

- Heating at T > 1093K ➡ Prevention of ferrite formation

- Relationship

  $A_{3(OE)\ at\ 0\%C} > A_{3(PE)} \cong T_{DC} \cong A_{3(NPLE)}$