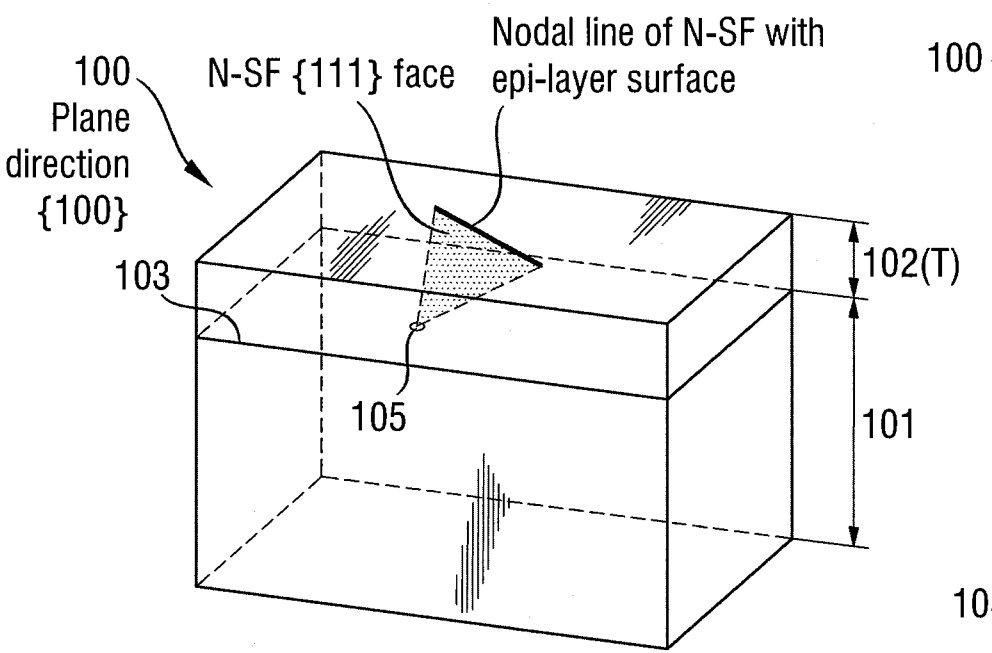


Fig. 1a

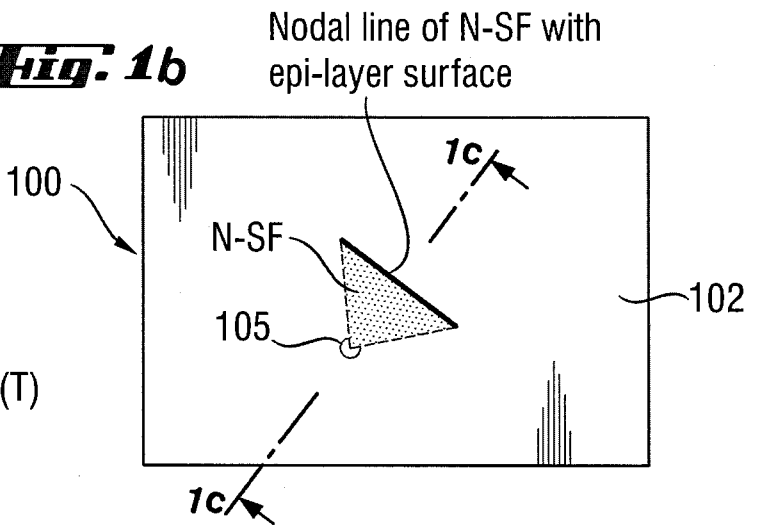


Fig. 1b

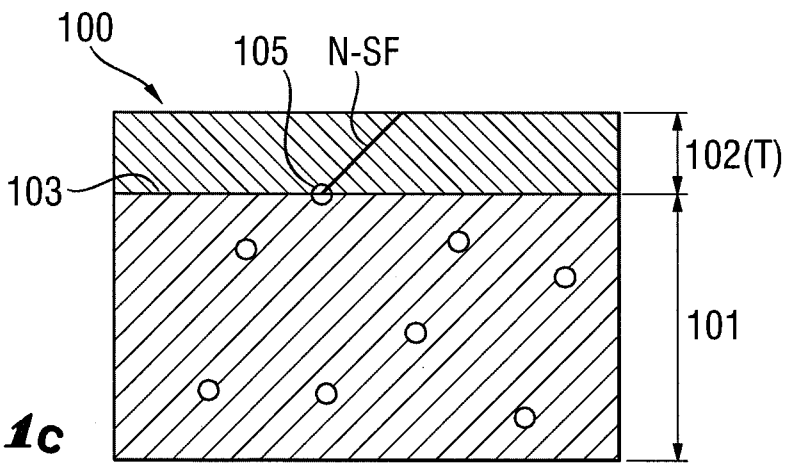


Fig. 1c

Fig: 2a

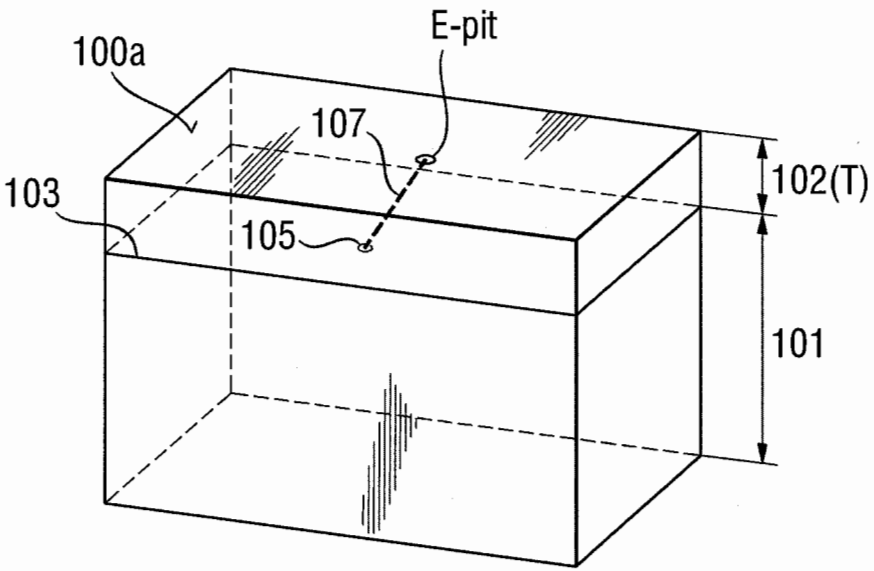


Fig: 2b

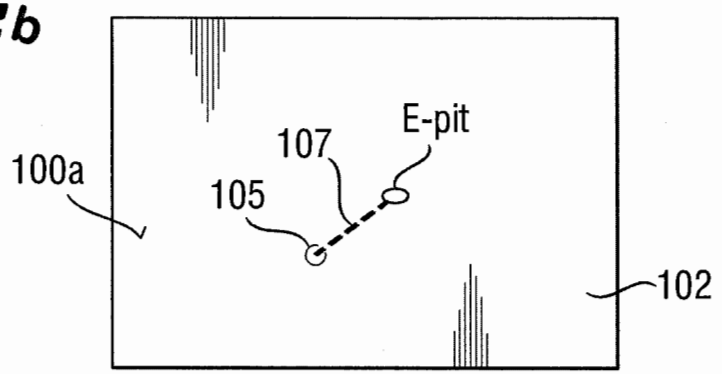


Fig: 2c

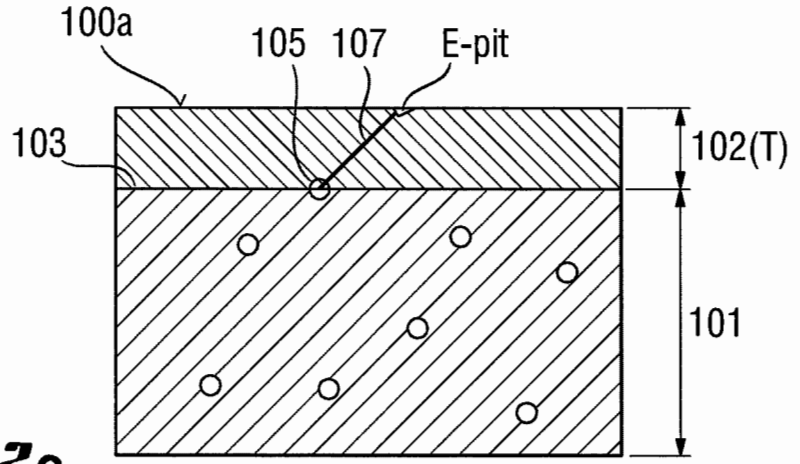


Fig. 3a

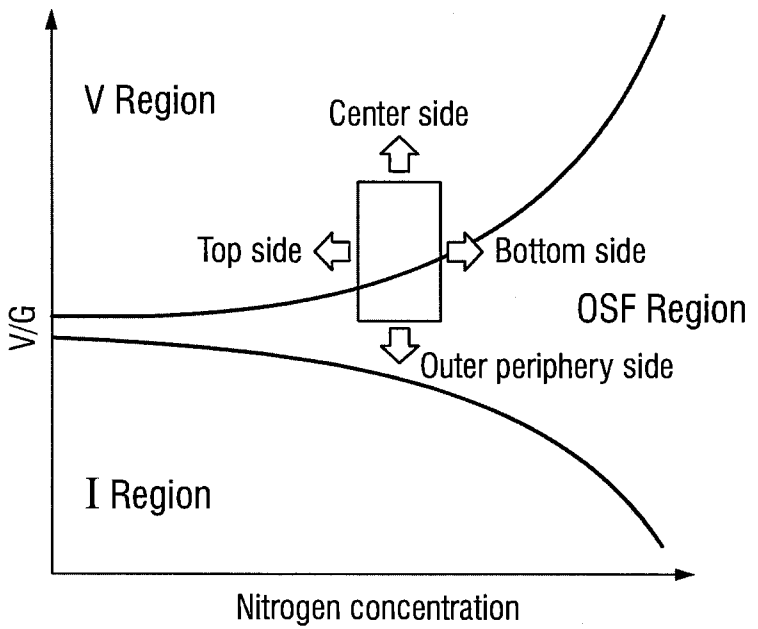

V Region
Center side
Top side
Bottom side
OSF Region
V/G
Outer periphery side
I Region
Nitrogen concentration

Fig. 3b

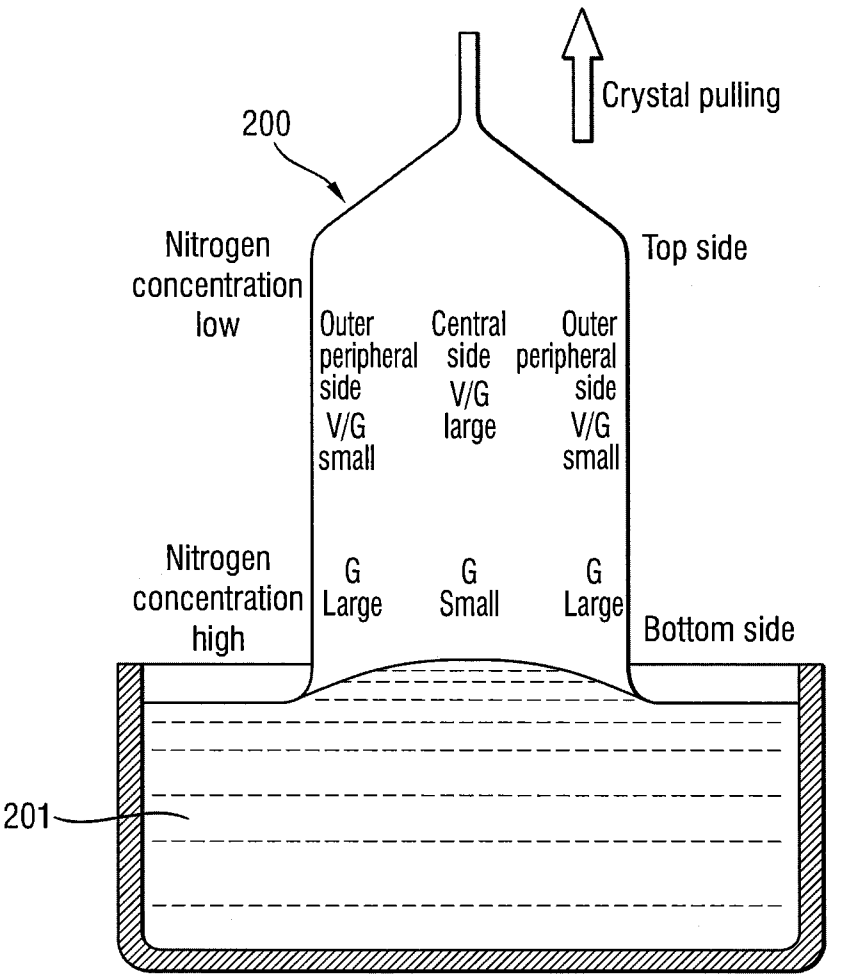

Crystal pulling
200
Nitrogen concentration low
Top side
Outer peripheral side V/G small
Central side V/G large
Outer peripheral side V/G small
Nitrogen concentration high
G Large
G Small
G Large
Bottom side
201

Fig. 4a

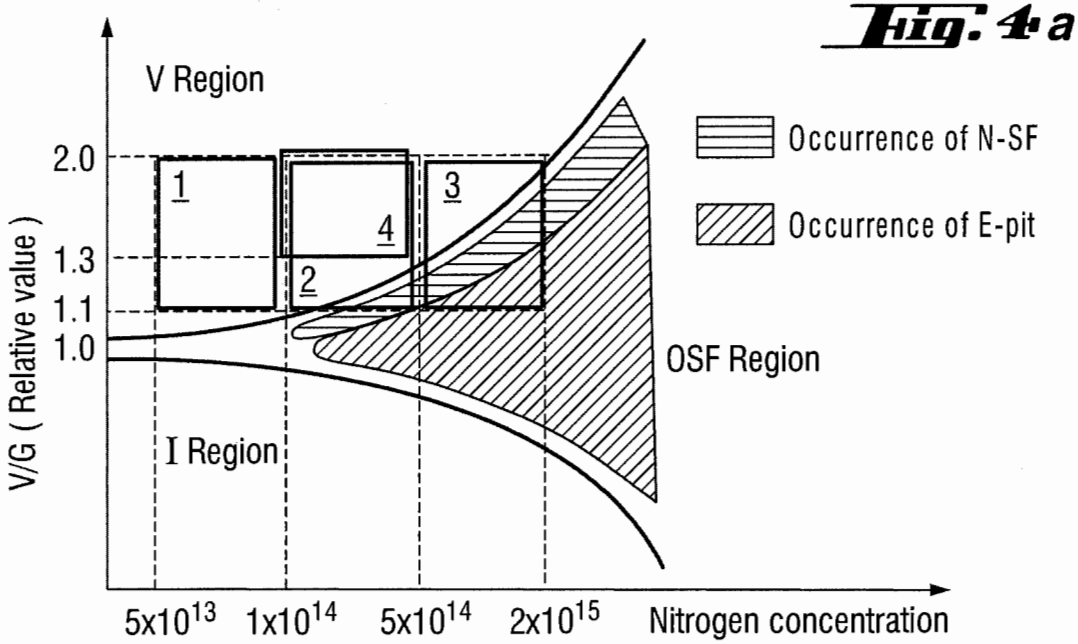

V Region
2.0
1.3
1.1
1.0
V/G (Relative value)
1
2
3
4
I Region
OSF Region
Occurrence of N-SF
Occurrence of E-pit
5x10^13
1x10^14
5x10^14
2x10^15
Nitrogen concentration

Fig. 4b

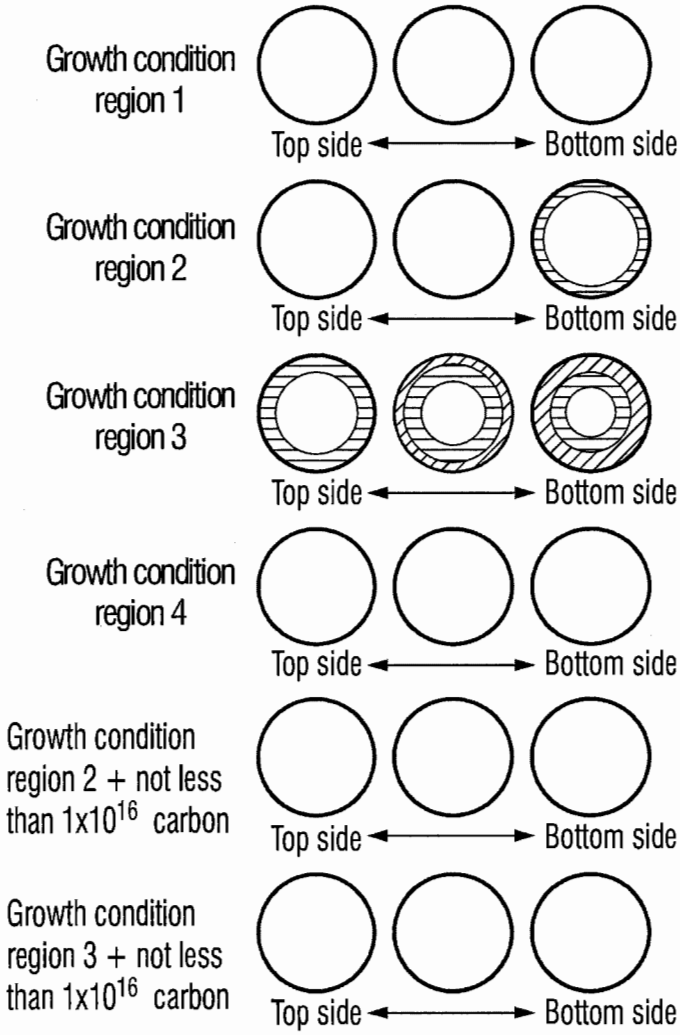

Growth condition region 1
Top side
Bottom side
Growth condition region 2
Top side
Bottom side
Growth condition region 3
Top side
Bottom side
Growth condition region 4
Top side
Bottom side
Growth condition region 2 + not less than 1x10^16 carbon
Top side
Bottom side
Growth condition region 3 + not less than 1x10^16 carbon
Top side
Bottom side

Fig. 5a

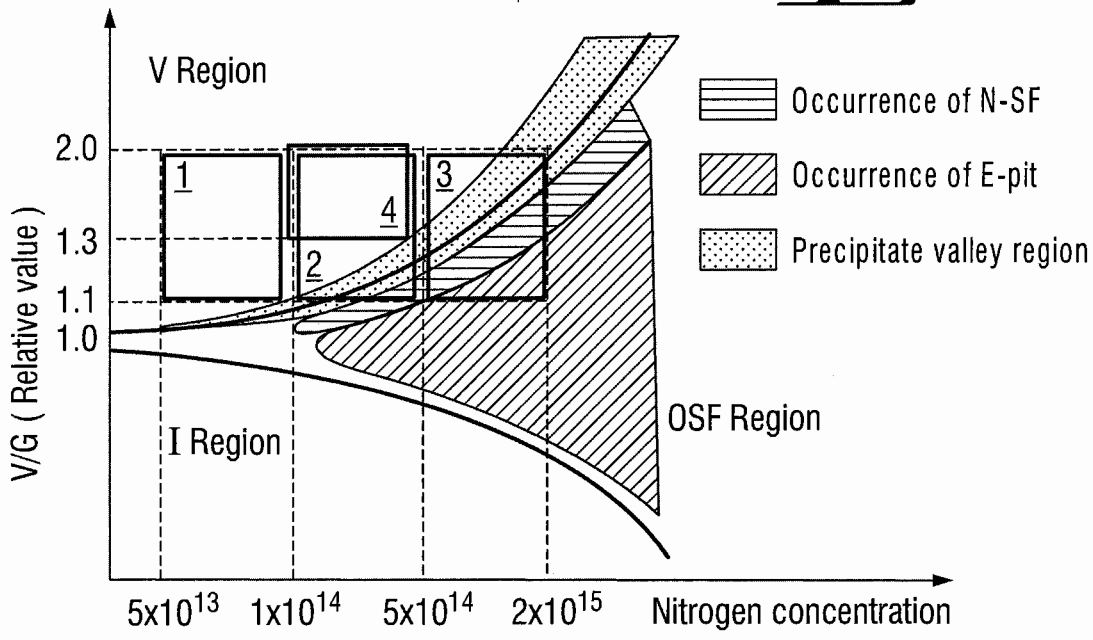


Fig. 5b

	Epi-Layer fault	Density of precipitate not less than 10^9 / cm^3	In-plane dispersion of density of precipitate not more than 0.5
Growth condition region 1 (Top side ⟷ Bottom side)	○	×	○
Growth condition region 2 (Top side ⟷ Bottom side)	○	×	×
Growth condition region 3 (Top side ⟷ Bottom side)	×	○	×
Growth condition region 4 (Top side ⟷ Bottom side)	○	×	○
Growth condition region 2 + not less than $1x10^{16}$ carbon (Top side ⟷ Bottom side)	○	×	×
Growth condition region 3 + not less than $1x10^{16}$ carbon (Top side ⟷ Bottom side)	○	○	×

Fig. 6a

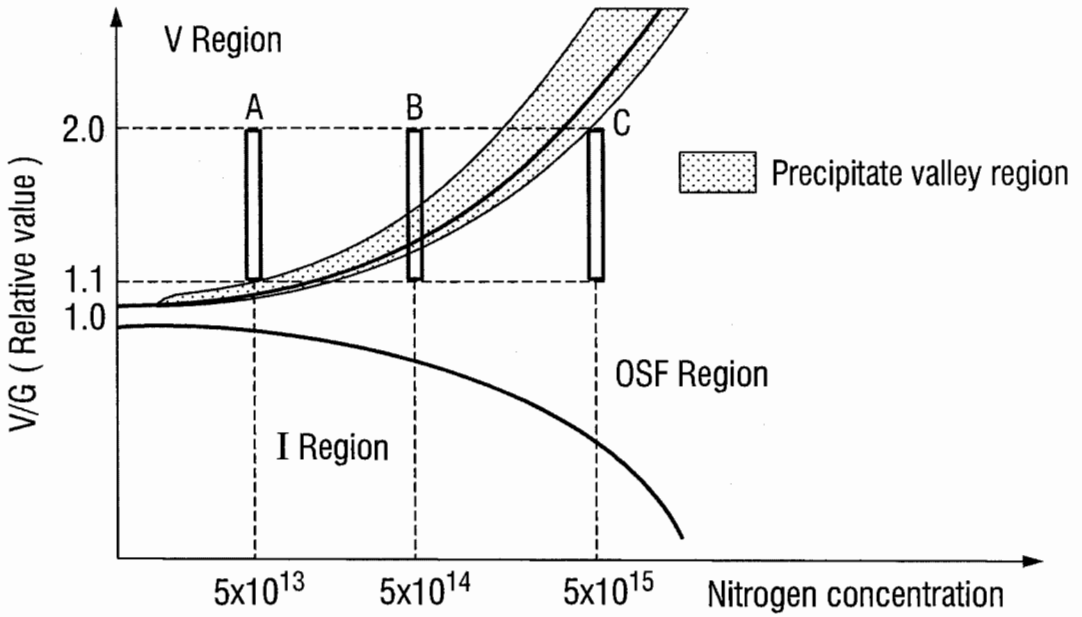

V Region
A
B
C
2.0
1.1
1.0
V/G (Relative value)
Precipitate valley region
OSF Region
I Region
5x10^13
5x10^14
5x10^15
Nitrogen concentration

Fig. 6b

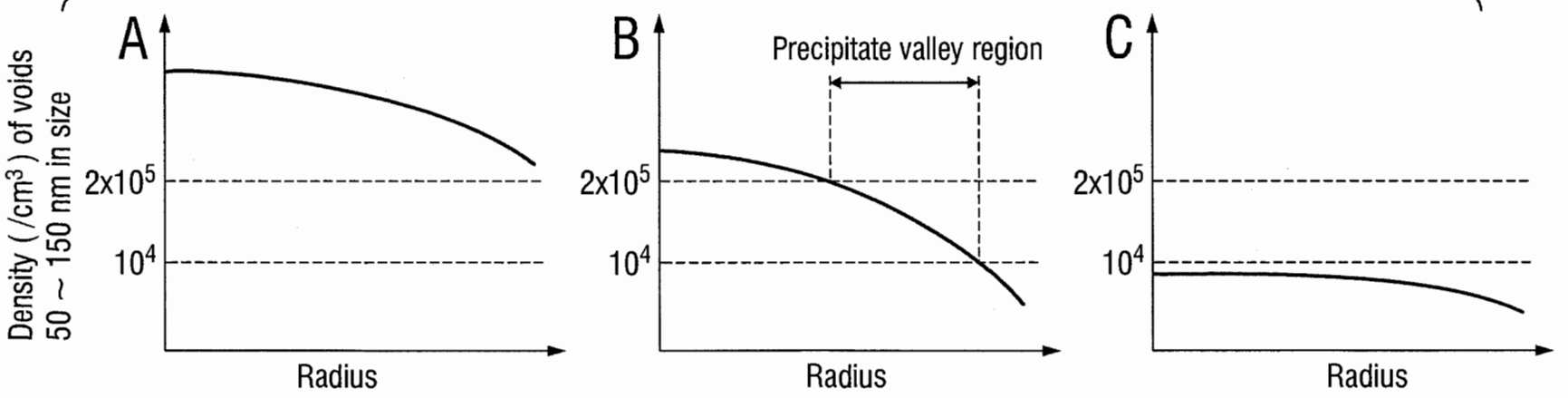

Density (/cm^3) of voids
50 ~ 150 nm in size
A
B
C
Precipitate valley region
2x10^5
10^4
Radius
Radius
Radius

Fig. 7a

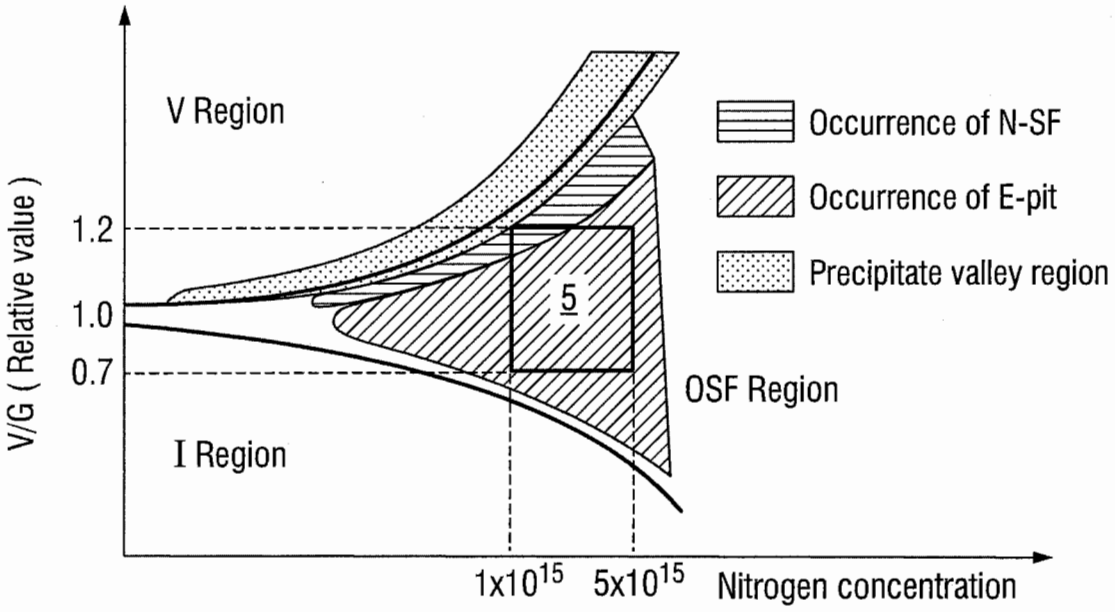


Fig. 7b

		Epi-Layer fault	Density of precipitate not less than 10^9 / cm^3	In-plane dispersion of density of precipitate not more than 0.5
Growth condition region 5	Top side ⟷ Bottom side	×	○	○
Growth condition region 5 + not less than $1x10^{16}$ carbon	Top side ⟷ Bottom side	×	○	○

Fig. 8a

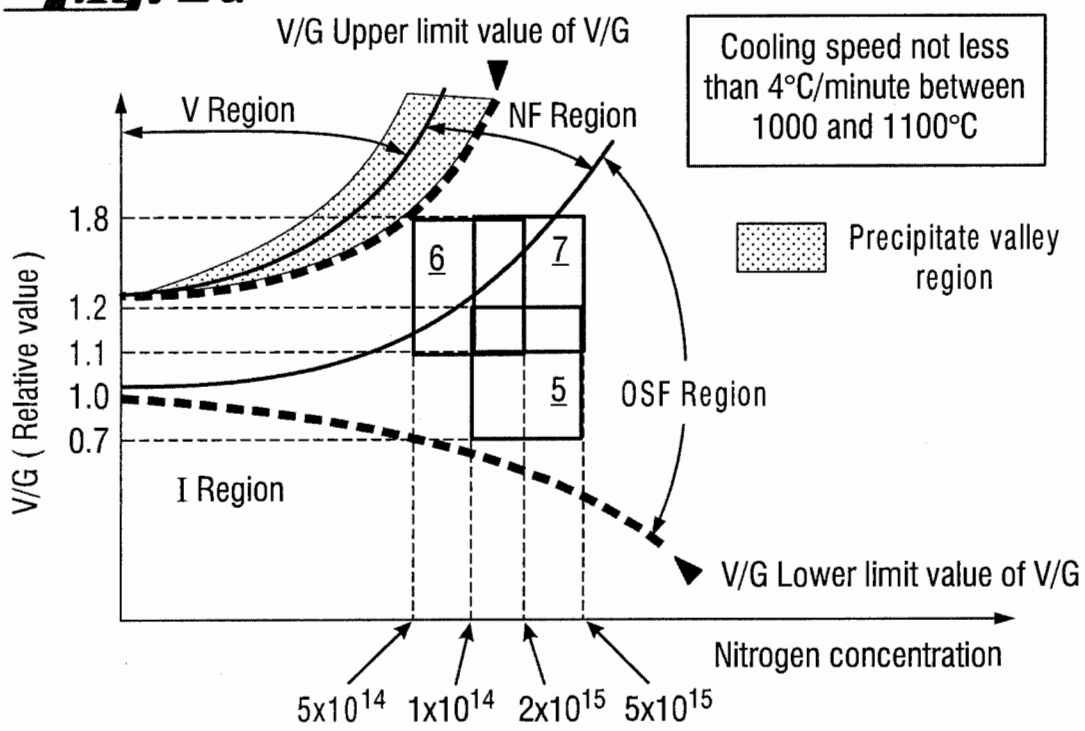


Fig. 8b

		Epi-Layer fault	Density of precipitate not less than 10^9 / cm^3	In-plane dispersion of density of precipitate not more than 0.5
Growth Condition Region 5 + not less than $1x10^{16}$ of carbon + not less than 4°C/minute between 1000 and 1100°C	Top side ⟷ Bottom side	○	○	○
Growth Condition Region 6 + not less than $1x10^{16}$ of carbon + not less than 4°C/minute between 1000 and 1100°C	Top side ⟷ Bottom side	○	○	○
Growth Condition Region 7 + not less than $1x10^{16}$ of carbon + not less than 4°C/minute between 1000 and 1100°C	Top side ⟷ Bottom side	○	○	○