Precipitate Coarsening during Ageing (LSW Theory)

Mean precipitate radius after ageing by Lifshitz–Slyozov–Wagner coarsening, with an Arrhenius diffusivity, the rate constant and the time to reach a radius.

Method: Lifshitz–Slyozov–Wagner coarsening

Input parameters

Unit system: SI

Parameter	Value	Unit
Initial mean radius	5.0000	nm
Interfacial energy (J/m²)	0.20000	N/m
Solute concentration in equilibrium with a flat interface	500.00	mol/m³
Molar volume of the precipitate	10.000	cm³/mol
Diffusivity pre-exponential	0.10000	cm²/s
Activation energy	130.00	kJ/mol
Ageing temperature	200.00	°C
Ageing time	100.00	h
Target radius	20.000	nm

Calculated results

Parameter	Value	Unit
Diffusivity at temperature	4.4523e-16	cm²/s
Coarsening rate constant	1.0060e-31	
Mean radius after ageing	5.4426	nm
Time to reach the target radius	21,744	h

Notes for this case

• LSW: r̄³ − r̄₀³ = kt, k = 8γc_eV_m²D/(9RT) with γ in J/m² (numerically N/m). Coarsening lowers strength after peak ageing (over-ageing); the cube law means a tenfold longer time grows particles only about 2.2 times. Volume fraction effects and interface-controlled growth change the constant.

Formula and method

$$\bar{r}^3 - \bar{r}_0^3 = kt, \quad k = \frac{8\gamma c_e V_m^2 D}{9RT}, \quad D = D_0 e^{-Q/RT}$$

Variables

$\bar{r}_0$	Initial mean radius	m
γ	Interfacial energy (J/m²)	N/m
c_e	Solute concentration in equilibrium with a flat interface	mol/m³
V_m	Molar volume of the precipitate	m³/mol
D_0	Diffusivity pre-exponential	m²/s
Q	Activation energy	J/mol
T	Ageing temperature	K
t	Ageing time	s
$\bar{r}_t$	Target radius	m
D	Diffusivity at temperature	m²/s
k	Coarsening rate constant	-

$\bar{r}$	Mean radius after ageing	m
t_r	Time to reach the target radius	s

Method and standards

Coarsening.

Assumptions and limits

- Diffusion-controlled, dilute, steady-state coarsening.

References

Lifshitz–Slyozov–Wagner coarsening

Report details

Report reference	FCC-BDRR-7FSM (the same inputs always give the same reference)
Generated	23 November 2026, 18:01 UTC
Calculator	Precipitate Coarsening during Ageing (LSW Theory)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/heat-treatment/precipitate-coarsening-lsw

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.