

Outline

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List of Notations and Symbols

k	Kappa carbide
γ	Austenite
β	Beta Manganese phase
δ	Delta ferrite
λ	Wavelength
ε	Equivalent strain
σ_{ss}	Solid solution Strengthening
C_i	Concentration in mass percentage for the i^{th} element
K_i	Coefficient for the i^{th} element
$\Delta\sigma_g$	Difference in grain size strengthening effect
K, K_3	Grain size strengthening parameter
g	Grain size
g_0	Initial grain size
g_f	Grain size during MAF
$\Delta\sigma_p$	Dislocation strengthening
ρ_0	Initial dislocation density
ρ_f	Dislocation density during MAF
α	Taylor constant
M	Average Taylor factor
K_1, K_2	Dislocation strengthening constant
G	Shear modulus
E	Elastic modulus

ν	Poisson's ratio
Fe	Iron
Cr	Chromium
Al	Aluminium
Ni	Nickel
C	Carbon
Si	Silicon
Mn	Manganese
Mg	Magnesium
Cu	Copper
Ti	Titanium
S_1, S_2, S_3	Orthogonal sample reference axes
L_1, L_2, L_3	Orthogonal laboratory/beam axes
ω	Incident angle
χ	Rotation angle of the sample
ψ	Angle between axis normal to sample surface and plane normal.
Φ	Angle of sample rotation about its surface normal
2θ	Diffraction angle
d	Interplanar spacing
ϵ_N	Normal strain
d_0	Interplanar spacing of annealed sample
ϵ_{33}	Strain on L_3 plane and along L_3 direction
P	Indices for sample axes
q	Indices for plane normals
ϵ_{pq}	Strain in the p plane and in the q direction

i	Index for laboratory axes
a_{ij}	Direction cosine
a_1	Average macrostrain
a_2	Mean macrostrain
δ_{pq}	Kronecker delta
σ_{eq}	Equivalent stress
A	Initial yield strength
B	Strength coefficient
C	Strain sensitivity
m	Thermal softening exponent
n	Strain hardening exponent
$\dot{\epsilon}$	Strain rate
$\dot{\epsilon}_0$	Reference strain rate
T_r	Room temperature
T_m	Melting temperature
m_0	Slopes at $\Phi=0^\circ$
m_{45}	Slopes at $\Phi=45^\circ$
m_{90}	Slopes at $\Phi=90^\circ$
n_0	Slopes at $\Phi=0^\circ$
n_{90}	Slopes at $\Phi=90^\circ$
c	Intercept
$\sigma_{11}, \sigma_{22}, \sigma_{33}$	Normal residual stresses
$\sigma_{12}, \sigma_{23}, \sigma_{13}$	Shear residual stresses

List of Abbreviations

MAF	Multiaxial forging
FEA	Finite element Analysis
SPD	Severe plastic deformation
IF	Interstitial free
HSS	High strength steel
AHSS	Advanced high strength steel
HSLA	High strength low alloy
H13	Hot worked tool steel
BCC	Body centred cubic
FCC	Face centred cubic
DDRX	Discontinuous dynamic recrystallization
cDRX	Continuous dynamic recrystallization
ECAP	Equal channel angular pressing
HPT	High pressure torsion
ARB	Accumulative roll bonding
JC	Johnson-Cook
KH	Khan-Haung
GA	Genetic algorithm
CPFEM	Crystal plasticity finite element method
XRD	X-Ray diffraction
EBSD	Electron back scatter diffraction
SEM	Scanning electron microscopy
TEM	Transmission electron microscopy
SFE	Stacking fault energy

YS	Yield strength
UTS	Ultimate tensile strength
TE	Total elongation
VHN	Viker hardness number
TWIP	Twinning induced plasticity
TRIP	Transformation induced plasticity
MSBs	Micro shear bands
WQ	Water quenched
S1	Fe-30Mn-9Al-0.8C steel
S2	Fe-20Mn-10Al-1C steel
FS1	Hot forged & WQ Fe-30Mn-9Al-0.8C steel
FS2	Hot forged & WQ Fe-20Mn-10Al-1C steel
SS1	Solutionised & WQ Fe-30Mn-9Al-0.8C steel
SS2	Solutionised & WQ Fe-20Mn-10Al-1C steel
MAF-0	Zero pass solutionised & WQ workpiece
MAF-1	One pass solutionised & WQ workpiece
MAF-2	Two pass Solutionised & WQ workpiece
MAF-3	Three pass solutionised & WQ workpiece
MAF-5	Five pass solutionised & WQ workpiece
ASTM	American society for testing and materials
AARE	Average absolute relative error
R ²	Correlation coefficient
3D	Three dimensional
C3D8R	8-node linear hex element
CD43	4 node tetrahedral element

SDVs	State-dependent variables
VUMAT	Vectorized user material

