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List of Notations

L	Length (mm)
W	Width (mm)
T	Thickness (mm)
A_{ug}	Ultrasonic vibration amplitude (μm)
f_{ug}	Vibration frequency (kHz)
β_0	Initial phase angle
V_c	Grinding wheel speed (m/s)
V_w	Worktable feed rate (m/min)
a_p	Downfeed (μm)
Z	Stand-off distance (mm)
α	Nozzle angle (°)
Q	Flow rate (ml/h)
P	Pressure (bar)
F_t	Tangential grinding force (N)
F_n	Normal grinding force (N)
e_c	Specific grinding energy (J/mm^3)
h_{eq}	Equivalent chip thickness (nm)
R_a	Center line average surface roughness (μm)
R_q	Root mean square surface roughness (μm)
R_z	Ten-point mean surface roughness (μm)
S_a	Average surface roughness (nm)
S_q	Root means square surface roughness (nm)
S_t	Average peak to valley height (nm)

R_{pk}	Average peak height from core roughness profile (μm)
R_k	Core roughness profile (μm)
R_{vk}	Average valley depth from core roughness profile (μm)
S_k	Core roughness depth (μm)
S_{pk}	Reduced peak height (μm)
S_{vk}	Reduced valley depth (μm)
HV	Vickers hardness
σ'	Interfacial tension (dyn/cm)
$\Delta\rho$	Density difference (kg/m^3)
D_e	Equatorial diameter of the pendant drop (μm)
H	Correction factor for pendant drop
S	Shape factor of the pendant drop
g	Gravitational acceleration constant (m/s^2)
ϕ	Cone angle (°)
R	Nose radius (μm)
h	Protrusion height (μm)
K	Thermal conductivity (W/mK)
C_p	Specific heat capacity (J/kgK)
E	Young's modulus (GPa)
v	Poisson's ratio
ρ	Density (kg/m^3)
V_{ug}	Speed of the ultrasonic vibration along the longitudinal feed direction (mm/s)
ω	Angular speed of the grinding wheel (rad/s)
D	Diameter of the grinding wheel (mm)
V_{c_x}	Abrasive grit speed into horizontal segment (m/s)

V_{c_y}	Abrasive grit speed into vertical segment (m/s)
β	Angle subtended at the centre of the abrasive wheel and workpiece cutting arc (°)
τ	Time (s)
V_{fs}	Relative speed of abrasive grit with respect to the workpiece (m/min)
V_{cr}	Abrasive grit relative speed (m/s)
V_{cr_x}	Abrasive grit relative speed into horizontal (m/s)
V_{cr_y}	Abrasive grit relative speed into vertical segment (m/s)
S_x	Horizontal distance of single abrasive grit (μm)
S_y	Vertical distance of single abrasive grit (μm)
τ'	Time duration for movement of abrasive grit accompanying the cutting curvature (s)
τ''	Vibration period (s)
A_x	Horizontal vibration amplitude (μm)
l_c	Contact length (mm)
β'	Inclination angle for the line of contact (°)
L	Length of the horizontal projection of the contact line (mm)
A	Yield stress of the material under reference condition (MPa)
B	Strain hardening constant (MPa)
n	Strain hardening coefficient
C	Strengthening coefficient of strain rate
m	Thermal softening coefficient
σ	Equivalent flow stress (MPa)
ϵ_p	Equivalent plastic strain
$\acute{\varepsilon}_p$	Equivalent plastic strain rate
$\acute{\varepsilon}_o$	Reference plastic strain rate

T_w	Workpiece temperature (^oK)
T_m	Material melting temperature (^oK)
T_r	Reference ambient temperature (^oK)
T_{max}	Maximum grinding temperature (^oC)
ζ	Failure parameter
$\Delta\in_P$	Increment of equivalent plastic strain
$\in_f$	Equivalent strain to failure
σ *	Stress triaxiality factor (MPa)
σ_p	Hydrostatic pressure (MPa)
σ_{mises}	Von Mises equivalent stress (MPa)
D_1 to D_5	Failure or damage parameter
σ_{fr}	Frictional stress (MPa)
σ_n	Normal stress (MPa)
μ	Isotropic coefficient of friction
$\mu_{s.a}$	Surface tension of solid air
$\mu_{l.s}$	Surface tension of solid liquid
$\mu_{l.a}$	Surface tension of and liquid air
θ	Equilibrium contact angle
f_m	Magnetizing frequency (Hz)
MFI	Magnetic field intensity (Oe)
Al_2O_3	Aluminum oxide
SiC	Silicon carbide
CO_2	Carbon dioxide
MoS_2	Molybdenum disulfide
TiO_2	Titanium dioxide

CuO	Copper oxide
ZnO	Zinc oxide
MoS_2	Molybdenum disulfide
cBN	Cubic boron nitride
Ag	Silver
Cu	Copper
Fe	Iron
Cr	Chromium
Mo	Molybdenum
V	Vanadium
Mn	Manganese
C	Carbon
Si	Silicon
Ni	Nickel

List of Abbreviation

AISI	American iron and steel institute
BCC	Body centered cubic
CDG	Conventional dry grinding
CWG	Conventional wet grinding
MQL	Minimum quantity lubrication
UVAG	Ultrasonic vibration assisted grinding
UVADG	Ultrasonic vibration assisted dry grinding
UVAMQL	Ultrasonic vibration assisted minimum quantity lubrication grinding
1D	One-dimensional
2D	Two-dimensional
3D	Three-dimensional
XRD	X-ray diffraction
XRF	X-ray fluorescence
EDX	Energy-dispersive X-ray spectroscopy
MBN	Magnetic Barkhausen noise
HL	Hysteresis loop
BN	Barkhausen Noise
RMS	Root mean square
FEM	Finite element model
FEA	Finite element analysis
CFD	Computational fluid dynamics
CAD	Computer-aided design

G-ratio	Grinding ratio
CFs	Cutting fluids
IARC	International agency for research on cancer
PCBN	Polycrystalline cubic boron nitride
PCD	Polycrystalline diamond
LN_2	Liquid nitrogen
CNT	Carbon nanotube
MNCNT	Multi-wall carbon nanotube
SO	Soybean oil
SO+DW	Soybean oil-deionized water
NPs	Nanoparticles
NFs	Nanofluids
IEP	isoelectric point
AFM	Atomic force microscope
SEM	Scanning electron microscope
TEM	Transmission electron microscopy
BAC	Bearing area curve
ASTM	American society for testing and materials
ISO	International Organization for Standardization
NIOSH	National Institute for Occupational Safety and Health
SMr1	Peak material portion
SMr2	Valley material portion
wt.%	Weight percentage
Sbi	Surface bearing index
Sci	Core fluid retention index