

Electronic Supplementary Material

Ultrasonic vibration grinding of difficult-to-cut materials: force models and processability

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Table S1 List of symbols

UVAG	Ultrasonic vibration-assisted grinding	f	Vibration frequency
MQL	Minimum quantity lubrication	KIC	Fracture toughness of the workpiece material
NMQL	Nanofluid minimum quantity lubrication	G	Shear modulus (MPa)
CAG	Cryogenic air grinding	ζ	Indenter geometry factor
CMQL	Cryogenic Minimum quantity lubrication	β	Instantaneous friction angle (°)
EMQL	Electrostatic atomization minimum quantity lubrication	α	Instantaneous front angle (°)
EUVAG	Elliptic ultrasonic vibration-assisted grinding	b	Actual grinding width (mm)
TUVAG	Two-dimensional ultrasonic vibration grinding	γ	Abrasive front angle (°)
RUEG	Rotary ultrasonic end grinding	σ_{γ}	Standardized strength of the complete material
RUSG	Rotary ultrasonic vibration side grinding	C_H	Lateral crack depth (μm)
CFRP	Carbon fiber reinforced plastic	C_L	Lateral crack length (μm)
FEM	finite element models	σ_{HEL}	Equivalent forces on the Hugoniot
CZM	Cohesive zone method	a	Thermal softening characteristics parameters
ML	Machine learning	H_v	Vickers hardness
SVM	Support vector machine	v_w	Feed speed (mm/s)
GPR	Gaussian process regression	h_{max}	Maximum undeformed chip thickness (μm)
a_p	Cutting depth of grain (mm)	θ	Cone top angle (°)
v_w	Workpiece velocity (m/s)	l_i	Movement arc length (mm)
v_s	Wheel velocity (m/s)	S	Contact area (mm^2)
K_C	The fracture toughness of the workpiece material	H_v	Vickers hardness (HW)
N	Total number of grinding wheel	N_{cutt}	Number of cutting abrasives
d_s	Diameter of the grinding wheel (mm)	N_{dsl}	The dynamic active abrasives in sliding
φ	Phase angle (°)	N_{DPL}	The dynamic effective grains in ploughing
A	Amplitude (μm)	F_{NSL}	The normal sliding force (N)