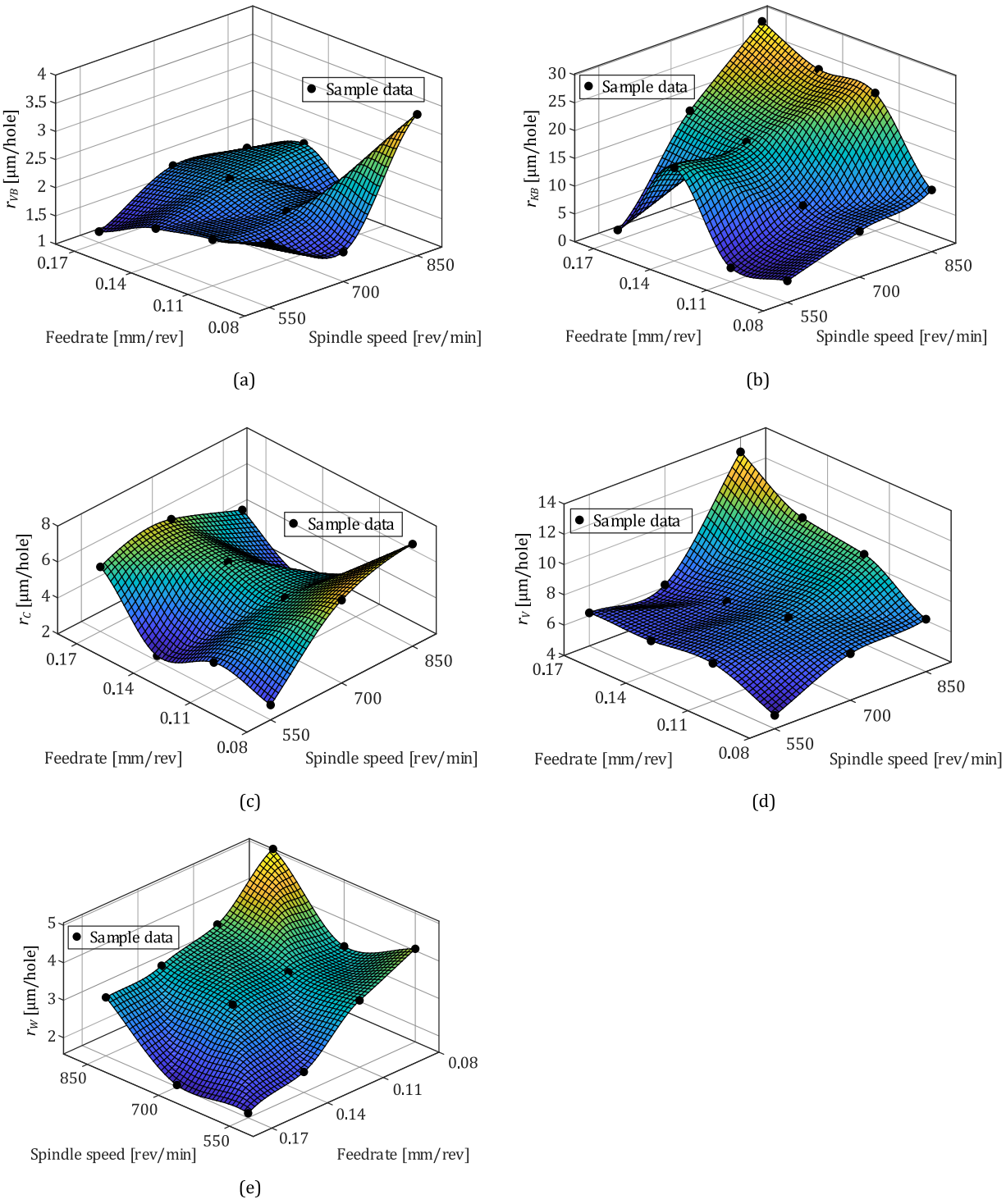

Fig. 10. Drill wear rate at different cutting parameters: (a) flank wear *VB*, (b) crater wear *KB*, (c) chisel wear C_ψ, (d) chisel wear V_ψ, (e) outer corner wear *W*.

manufacturer's manual, the scope of the cutting parameters in Eq. (4) is set as: 550 rev/min $\leq s \leq$ 850 rev/min and 0.08 mm/rev $\leq f \leq$0.17 mm/rev. The threshold values of different wear types are set as per the experiment results and listed in Table 10. The tool changing time in Eq. (2) is set as $T_c = 5$ min. This is a reasonable time in practical situation considering tool installation, presetting and adjustment.

The solving process was programmed based on the procedure in Section 4.4 with Matlab 2018b. As hole surface roughness is changed with different cutting parameters, drill wear and drilling forces, a portion of the randomly generated particles are feasible solutions and the others are not at the beginning of the optimization procedure. The optimization is conducted with the proposed

Table 9
Parameter settings in PSO.

Parameters in PSO	Set value
Swarm size	100
Maximum iteration number	60
c_1	2.05
c_2	2.05