

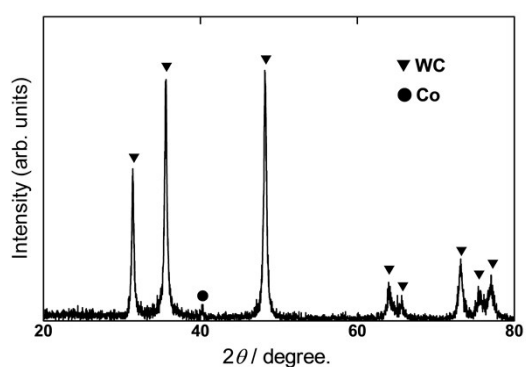


Fig. S1 XRD pattern of WC-Co_{carbide} prepared by
carburization of W-Co_{alloy} powder at 1173 K for 32.4 ks.

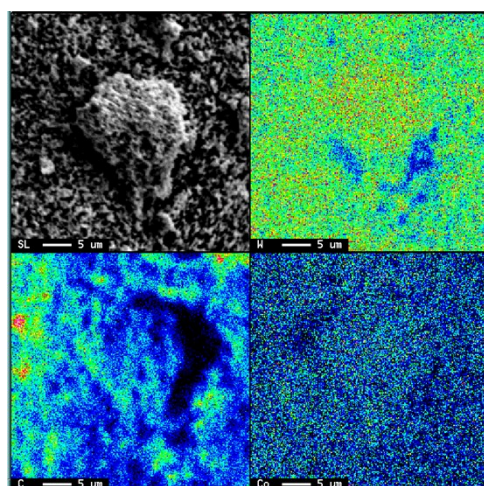


Fig. S3 EPMA images of WC-Co_{carbide} prepared by
carburization of W-Co_{alloy} powder at 1173 K: SEM
image; W $L\alpha$ image; C $K\alpha$ image; Co $K\alpha$ image.

Table S1 Summary of the thermodynamic values at 298.15 K and their uncertainties, U , of the substances of interest.

Substances	$\Delta_f H_m^\circ$ / (kJ (mol of compd.) ⁻¹)	$U(\Delta_f H_m^\circ)$ / (kJ J (mol of compd.) ⁻¹)	S_m° / (J K ⁻¹ (mol of compd.) ⁻¹)	$U(S_m^\circ)$ / (J K ⁻¹ (mol of compd.) ⁻¹)	$\Delta_f G_m^\circ$ / (kJ (mol of compd.) ⁻¹)	$U(\Delta_f G_m^\circ)$ / (kJ kJ (mol of compd.) ⁻¹)	Refs.
WC(cr)	-40.166	-	32.384	-	-38.372	-	(38)
WB(cr)	unknown	-	unknown	-	-123.82	± 4.95 ^a	(37)
NH ₃ BH ₃ (cr)	-178.0	± 5.9	unknown	-	unknown	-	(34)
NH ₃ (aq)	-81.170	± 0.326	109.040	± 0.913	-26.673	± 0.305	(35)
NH ₄ ⁺ (aq)	-133.260	± 0.250	111.170	± 0.400	-79.398	± 0.278	(35)
B(OH) ₃ (aq)	-1072.800	± 0.800	162.400	± 0.600	-969.268	± 0.820	(35)
BO ₂ ⁻ (aq)	-772.37	± 0.56 ^b	-37.2	± 0.25 ^b	-678.89	± 0.57 ^b	(36)
H ₂ O(l)	-285.830	± 0.040	69.950	± 0.030	-237.140	± 0.041	(35)
H ₂ (g)	0.000	± 0.000	130.680	± 0.003	0.000	± 0.000	(35)

^a Extrapolated data of the temperature function $\Delta_f G_m^\circ$ (WB) at 1310 – 1399 K,³⁷ giving $U(\Delta_f G_m^\circ)$ of 4%.

^b Uncertainties of BO₂⁻(aq) were estimated to be equal to those of B(OH)₃(aq).

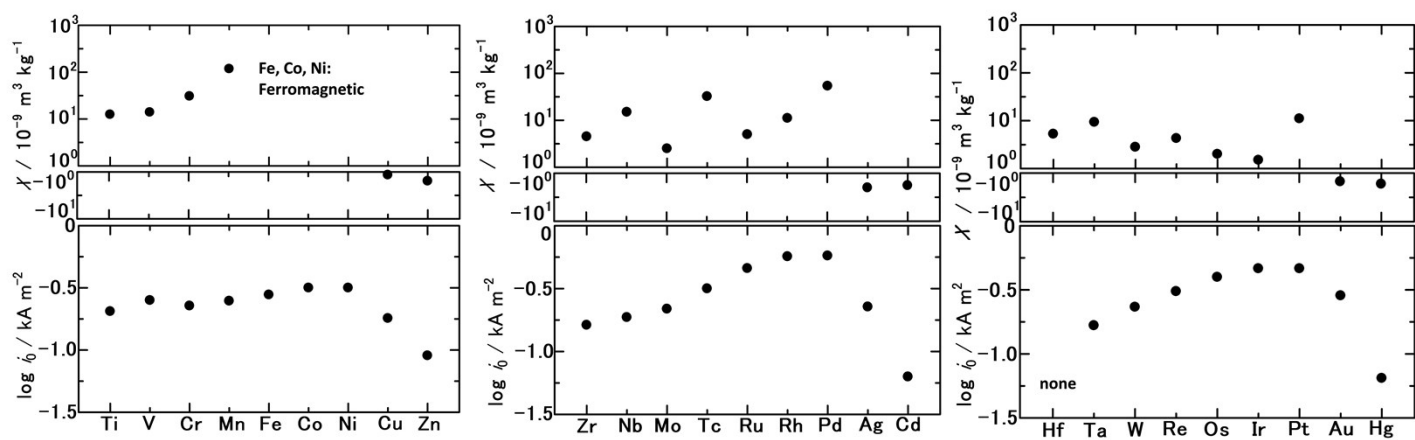


Fig. S4 Correlation between magnetic susceptibility, χ , and electrochemical HER current density i_0 determined by extrapolating the cathodic Tafel line to the reference hydrogen electrode (RHE) of the transition metals of the fourth, fifth and sixth periods.