Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information for

Multi-element co-penetration engineering in high-entropy alloys for efficient electromagnetic-wave absorption

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The corrosion resistance test in Fig. 4 (a-c) are as follows:

(1) An electrochemical workstation (CHI760E) is used to test the potentiodynamic polarization curve and electrochemical impedance spectra (EIS) in the 3.5 wt.% NaCl solution. The electrochemical tests adopt a three-electrode system. A sample-loaded carbon paper is used for the working electrode, and a platinum metal sheet and saturated calomel electrode (SCE) are used as auxiliary and reference electrodes, respectively. The open-circuit potential of samples is obtained after being soaked for 1800 s. The potentiodynamic polarization curves are measured at a scanning rate of 0.5 mV/s. Corrosion potential and corrosion current density are obtained from polarization curves. The EIS test is carried out with a scan amplitude of 5 mV and a frequency range of 100 kHz - 0.1 Hz.

(2) The samples were prepared as follows: first, 5 mg of sample powder, 120 μL of naphthol, 200 μL of isopropanol and 600 μL of deionized water were uniformly mixed. Subsequently, 35 μL of the mixed solution was added dropwise onto a carbon paper with size of 0.5 × 0.5 cm^2. Finally, these samples were dried at 60 °C for 10 minutes.

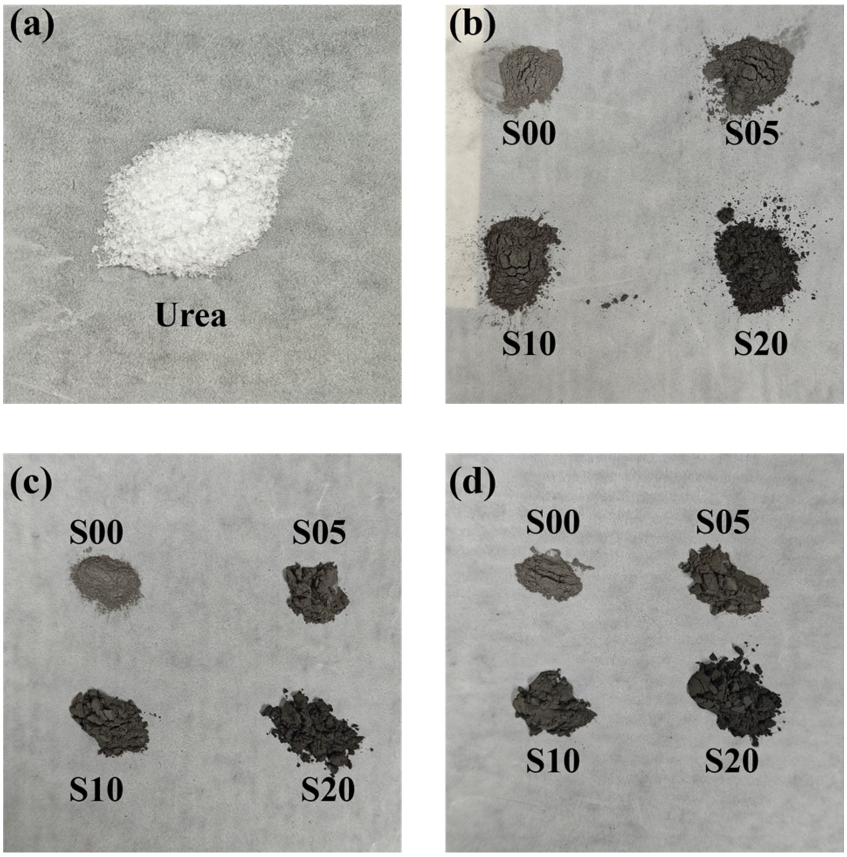

Fig. S1. The photographs of (a) urea and (b-d) the prepared samples (S00, S05, S10 and S20).

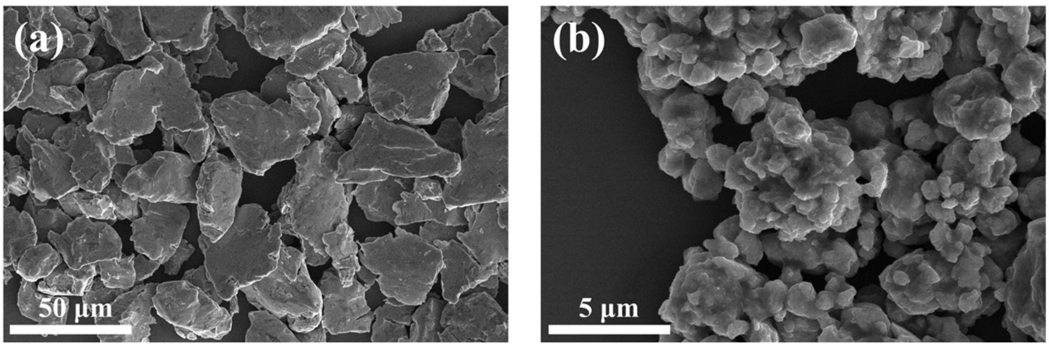

Fig. S2. Comparison of surface morphology between (a) S00 and (b) S20.

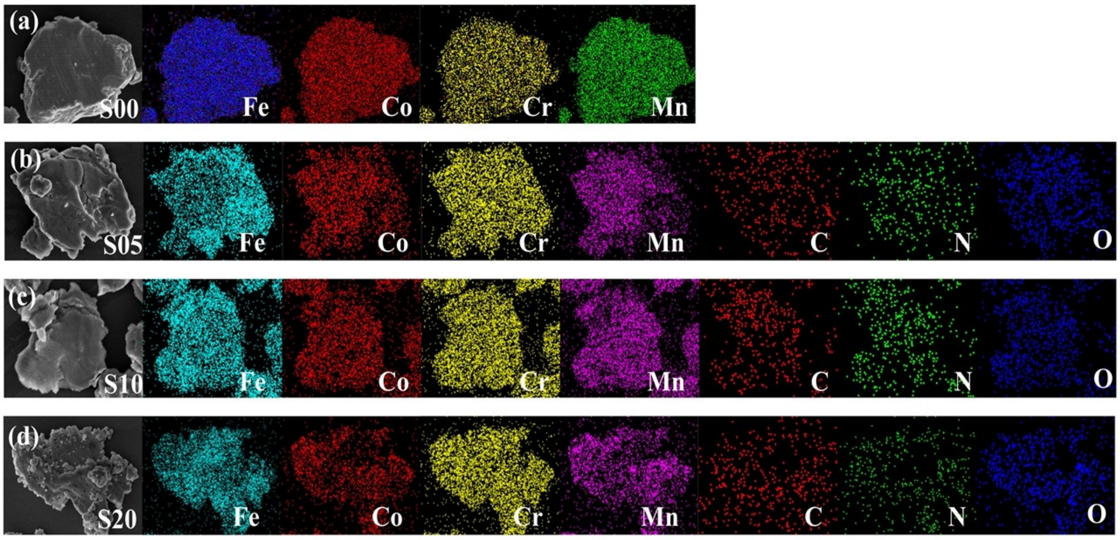

Fig. S3. EDS element mapping images of (a) S00, (b) S05, (c) S10 and (d) S20.

Table S1. Melting point, crystal structure, atomic radius and Pauling electronegativity of raw materials.

Element	Fe	Co	Cr	Mn	CH_4N_2O
Melting point (°C)	1538	1495	1907	1246	131~135
Crystal structure	BCC	HCP	BCC	BCC	-
Atomic radius (pm)	126	125	128	127	-
Pauling electronegativity	1.83	1.88	1.66	1.55	-

Table S2. Electrochemical parameters of equivalent circuit under different stray current density.

Samples	R_s	Q-Yo	Q-n	R_{ct1}	CPE	R_{ct2}
S00	2.573	0.00039495	0.75483	62.08	0.00031653	8097
S05	$5.2*10^{-6}$	0.0018084	0.45683	67.6	0.00029686	$1.4*10^{5}$
S10	3.908	0.0005724	0.7369	80.48	0.00042727	54605
S20	3.135	0.00045736	0.74153	116	0.00048825	$7.4*10^{17}$

Table S3. Comparison of corrosion-resistance performances of different HEAs.[1-6]

Samples	Solution	I_{corr} (μA/cm^2)	E_{corr} (mV)	Ref.
FeCoNiCu	3.5 wt.% NaCl	5.78	-0.43	Ref. 1
$FeCoNiCuAlCe_{0.01}$	3.5 wt.% NaCl	5.27	-0.43	Ref. 1
$FeCoNiCuAlCe_{0.03}$	3.5 wt.% NaCl	4.61	-0.43	Ref. 1
$FeCoNiCuAlCe_{0.09}$	3.5 wt.% NaCl	4.01	-0.45	Ref. 1
$FeCoNiAl_{0.3}$	3.5 wt.% NaCl	5.02	-0.204	Ref. 2
FeCoNiCrBSiNb	3.5 wt.% NaCl	5.20	-0.390	Ref. 3
$Ti_{21.6}Al_{11.3}Cr_{19.4}Si_{23.5}V_{22.0}O_{2.2}$	3.5 wt.% NaCl	6.14	-0.541	Ref. 4
FeCoNiCr	3.5 wt.% NaCl	2.51	-0.036	Ref. 5
FeCoNiMn	3.5 wt.% NaCl	4.90	-163	Ref. 6
S05	3.5 wt.% NaCl	2.62	-45.33	This work

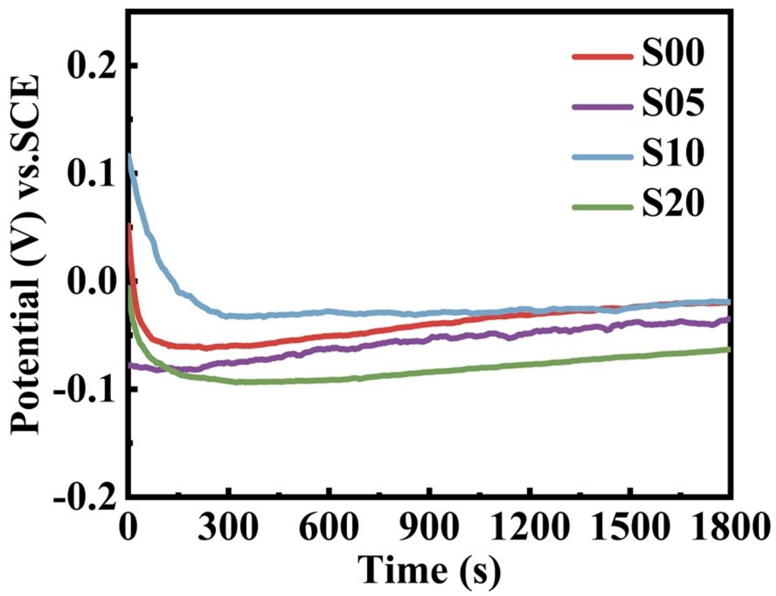

Fig. S4. Open-circuit potentials of C/N/O co-interstitial penetration FeCoCrMn HEAs.

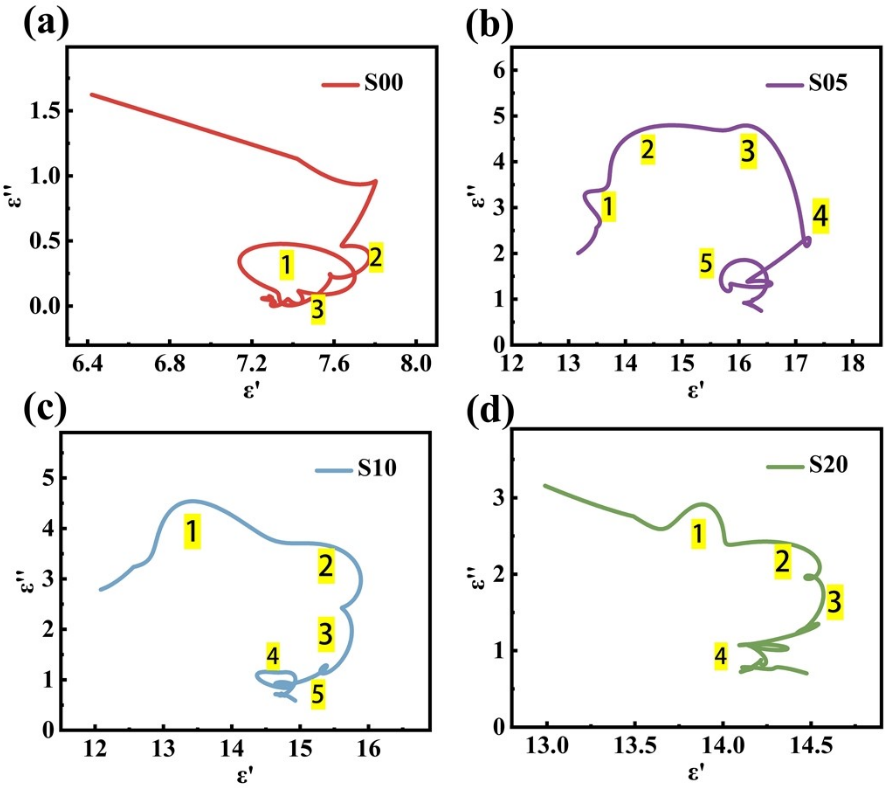

Fig. S5. The Cole–Cole semicircle patterns of (a) S00, (b) S05, (c) S10 and (d) S20.

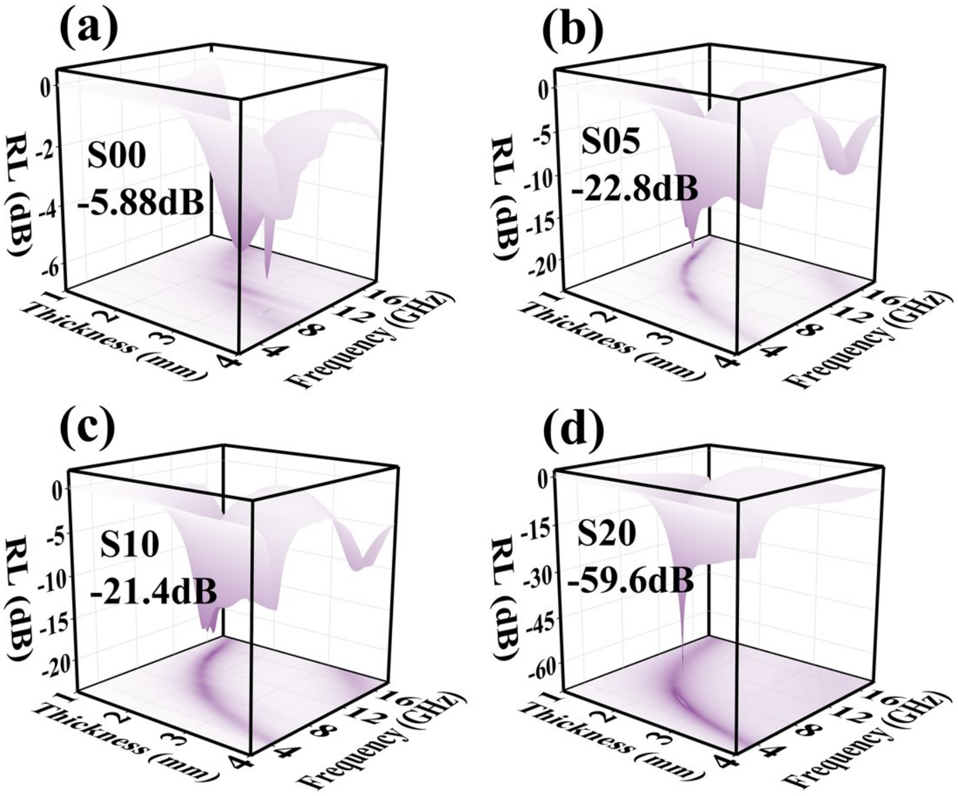

Fig. S6. The 3D RL plots as a function of frequency at various thicknesses of (a) S00, (b) S05, (c) S10 and (d) S20.

Table S4. The comparison of RL performances of all samples in this work.

Samples	**RL_{min} (dB)**	**Frequency (GHz)**	**Thickness (mm)**
S00	-5.9	/	/
S05	-22.8	13.12	1.46
S10	-21.4	14.54	1.37
S20	-59.6	6.06	2.48

Table S5. The comparison of comprehensive properties with related materials.[1, 5, 7-12]

Samples	RL (dB)	F (GHz)	EAB (GHz)	Thickness (mm)	I_{corr} (μA/cm^2)	Ref.
S20	-59.6	6.06	6.86	1.32	3.17	This work
$FeCoNiCuS_{0.2}$	-55.4	6.52	7	2.16	3.59	Ref.7
$FeCoNiCuC_{0.04}$	-61.1	15.28	5.1	1.6	5.14	Ref.8
$FeCoNiCuC_{0.10}$	-59.9	6.78	5.2	2.8	9.25	Ref.8
$FeCoNiCuC_{0.1}N_{0.2}$	-32.3	7.89	4.46	2.5	2.43	Ref.9
$FeCoNiCrB_{0.01}$	-64.5	12.43	5.08	2.66	8.729	Ref.5
HCN_S	-45.7	/	3.9	3.6	/	Ref.10
$FeCoNiMn_{0.5}Al_{0.2}$	-44.4	/	3.825	3	/	Ref.11
$FeCoNiCuAlCe_{0.09}$	/	/	/	/	4.01	Ref.1
$FeCoNiCuC_{0.09}N_{0.18}$	-55.8	15.82	3.82	2.38	0.51	Ref.12

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