Electronic Supplementary Information

Multicolored One-Dimensional Photonic Crystal Coatings with Excellent Mechanical Robustness, Strong Substrate Adhesion, Liquid and Particle Impalement Resistance

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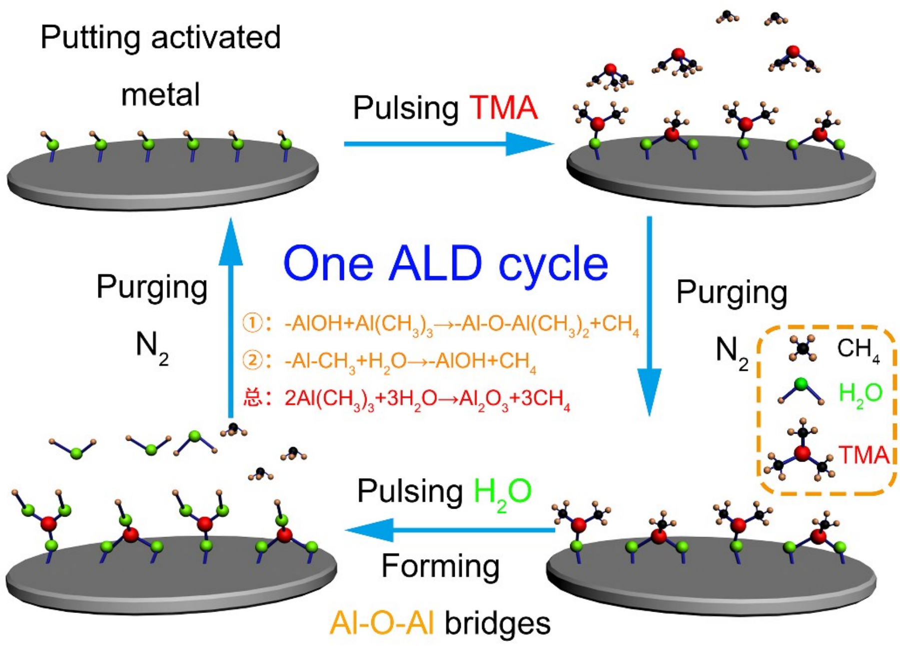

Fig. S1 Schematic illustration of ALD mechanism using Al_2O_3 as a sample, where TMA refers $Al(CH_3)_3$.

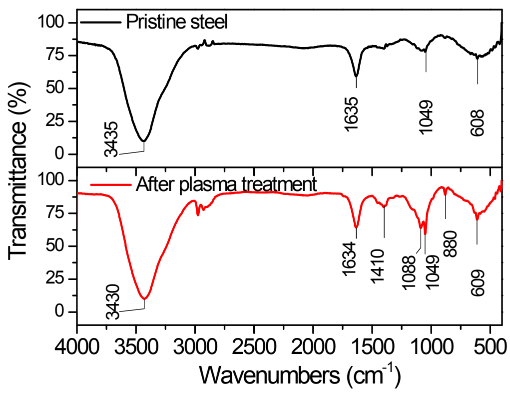

Fig. S2 FT-IR spectra of steel before and after surface air plasma treatment. After plasma treatment, the relative absorption bands at 1401 and 1088 cm^{-1}, ascribing to the stretching vibrations of C-N and C-O band respectively, increased remarkably, indicating the introduction of active functional groups for the following ALD reaction. This result was further supported by next water contact angle measurement.

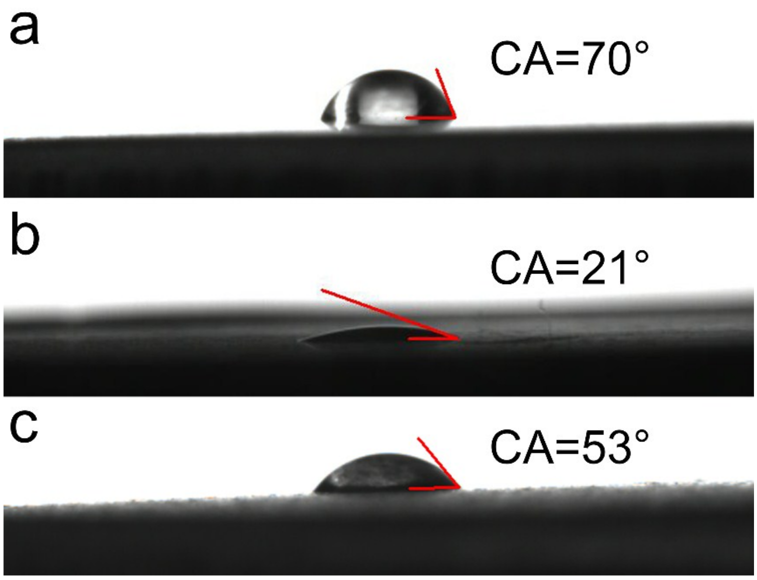

Fig. S3 Water contact angles of (a) pristine, (b) plasma treated, and (c) ALD deposited structural color steels.

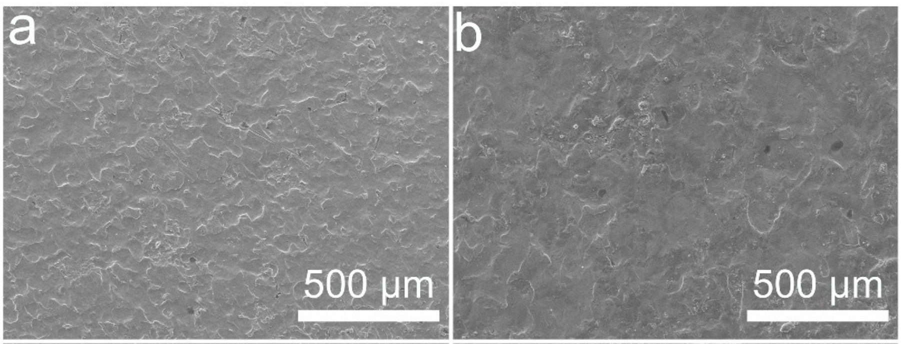

Fig. S4 Top-view SEM images of (a) pristine steel (b) photonic crystal structural color coating of Fe-3(400+400) sample.

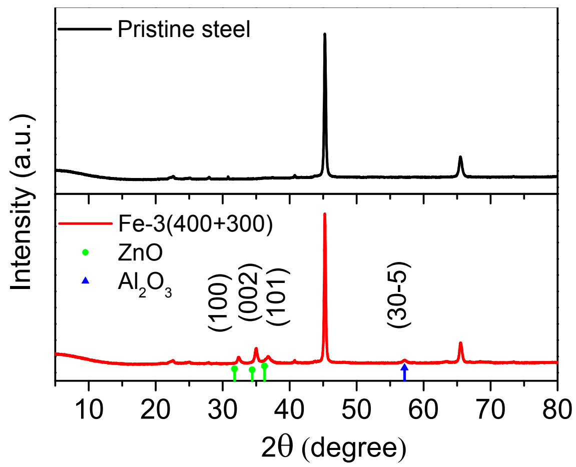

Fig. S5 XRD patterns of the pristine steel and Fe-3(400+300) sample. The diffractive peaks of Fe-3(400+300) agree well the standard with hexagonal ZnO (JCPDS No.36-1451) and monoclinic Al_2O_3 (JCPDS No.50-1496). The peaks at 32, 35, 36 degree are ascribed to (1 0 0) , (0 0 2) and (1 0 1) facets of ZnO, respectively. The one at 57 degree is attributed to (3 0 -5) facet of Al_2O_3.

Tab. S1 Comparison of the theoretical bandgap wavelengths and the measured reflection peaks of structural color coatings.

Sample	Film thickness (nm)		Theoretical bandgap wavelength (nm)	Reflection peak wavelength (nm)
	Al_2O_3	ZnO		
Fe-3(400+300)	62	64	454	456
Fe-3(400+400)	62	84	532	536
Fe-3(400+500)	62	97	583	590
Fe-3(400+600)	62	115	653	655
Fe-3(400+700)	62	132	719	718.

The Snell's law modified Bragg diffraction formula was given as follows:

$$k\lambda=2d(n^2-\sin\theta^2)^{1/2} \quad (1)$$

where λ refers the maximum reflective wavelength of structural color, k is diffraction order, d denote the periodic constant, n_{eff} is the effective refractive index of periodic structure, θ is the angle of incident light. Increasing the angle of incident light θ would cause the blue shift of the maximum reflective wavelength.

Fig. S6 Digital photos of patterned photonic crystal coatings.

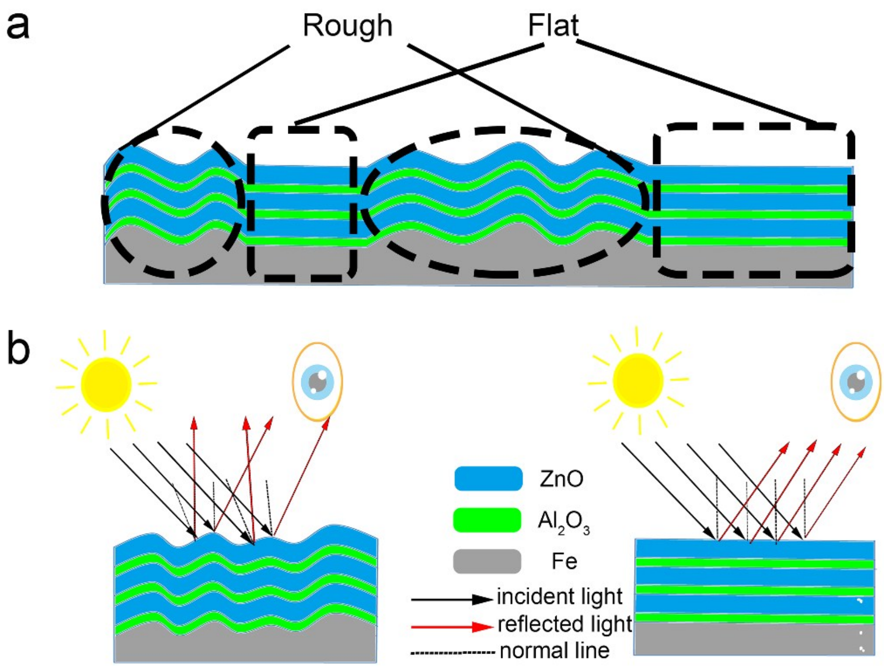

Fig. S7 Schematic illustration of (a) the microscopic surface of 1D photonic crystal coating on steel, and (b) the corresponding Bragg reflection on rough and flat regions.

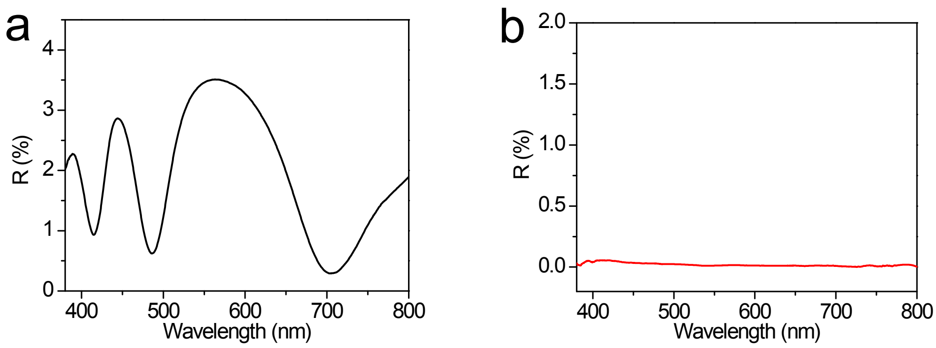

Fig. S8 Reflective spectra of 1D photonic crystal coating on silicon wafer when the incident and detection angle are (a) equal and (b) different.

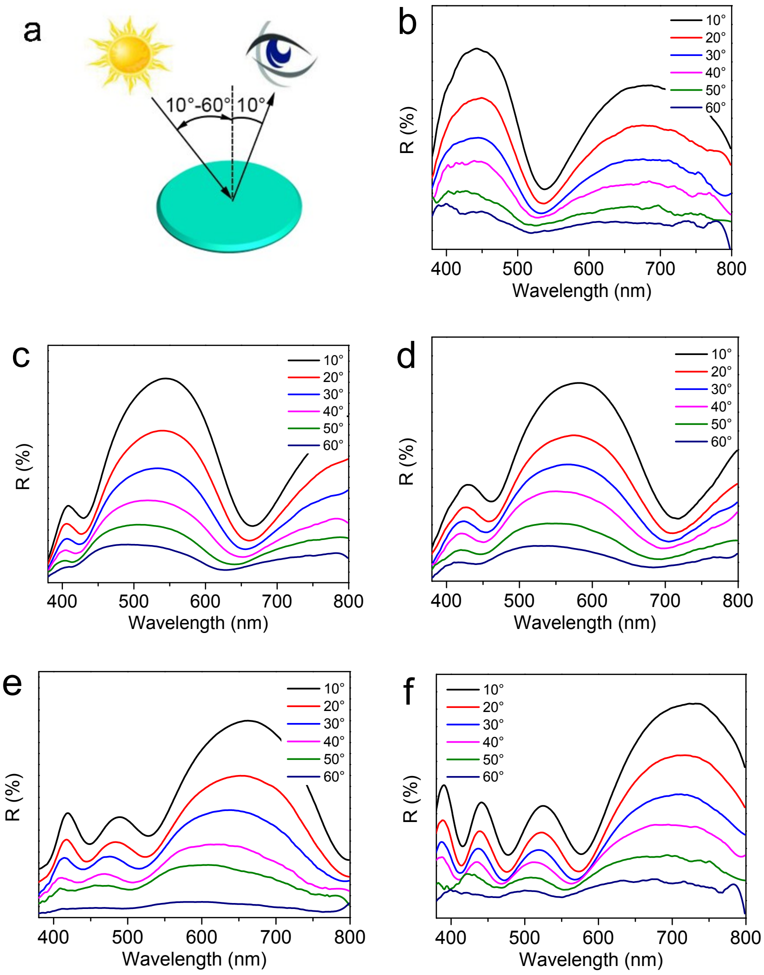

Fig. S9 Angle-resolved reflection spectra in diffusive reflection mode. (a) Illustration of measuring mode. The detection angle was fixed at 10° while the incident angle varied from 10° to 60°. Reflection spectra of (b) Fe-3(400+300), (c) Fe-3(400+400), (d) Fe-3(400+500), (e) Fe-3(400+600) and (f) Fe-3 (400+700).

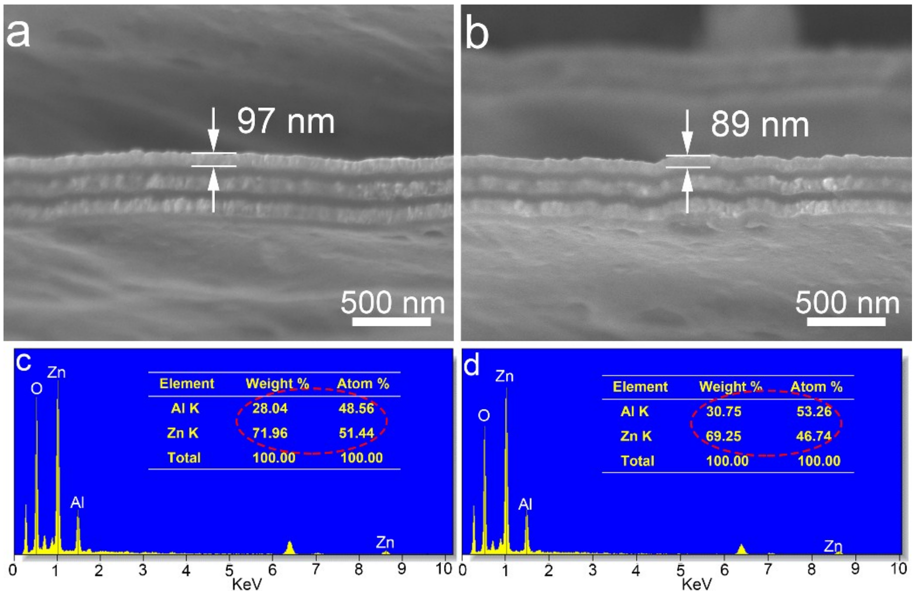

Fig. S10 Cross-sectional FESEM images of Fe-3(400+500) photonic crystal coating before and after tape peeling test: (a) before test, (b) after test and EDS spectrum: (c) before test, (d) after test.

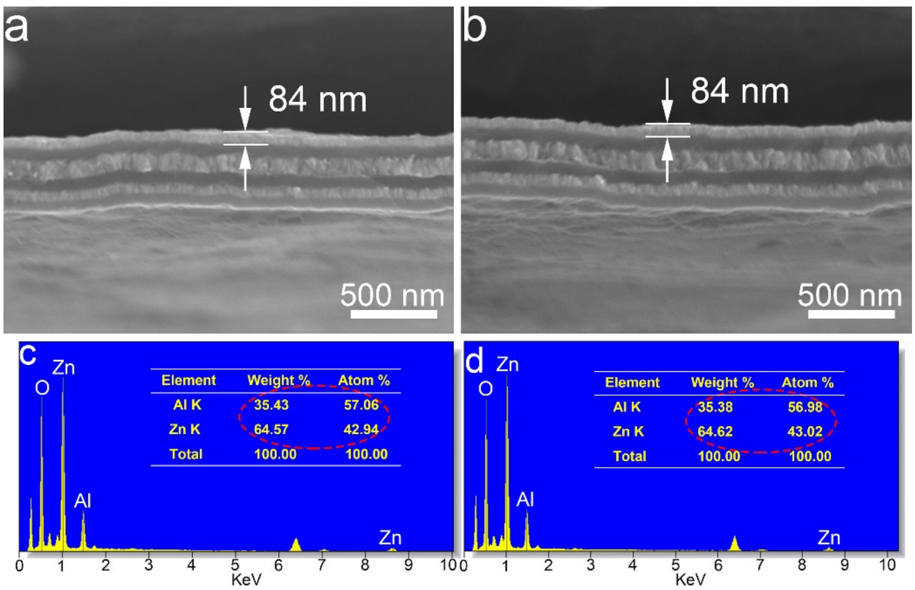

Fig. S11 Cross-sectional FESEM images of Fe-3(400+400) photonic crystal coating before and after tape peeling test: (a) before test (b) after test and EDS spectrum: (c) before test (d) after test.

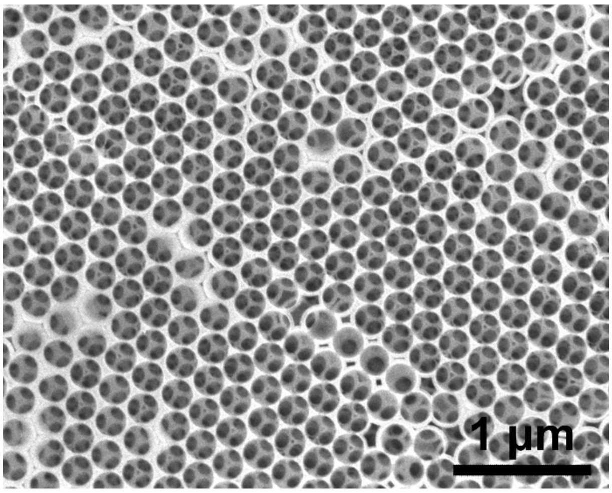

Fig. S12 FESEM images of TiO_2 inverse opal photonic crystal fabricated by atomic layer deposition.