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Influence of Carbon Nanodots Encapsulated Polycarbazole Hybrid on Corrosion Inhibition Performance of Polyurethane Nanocomposite Coatings

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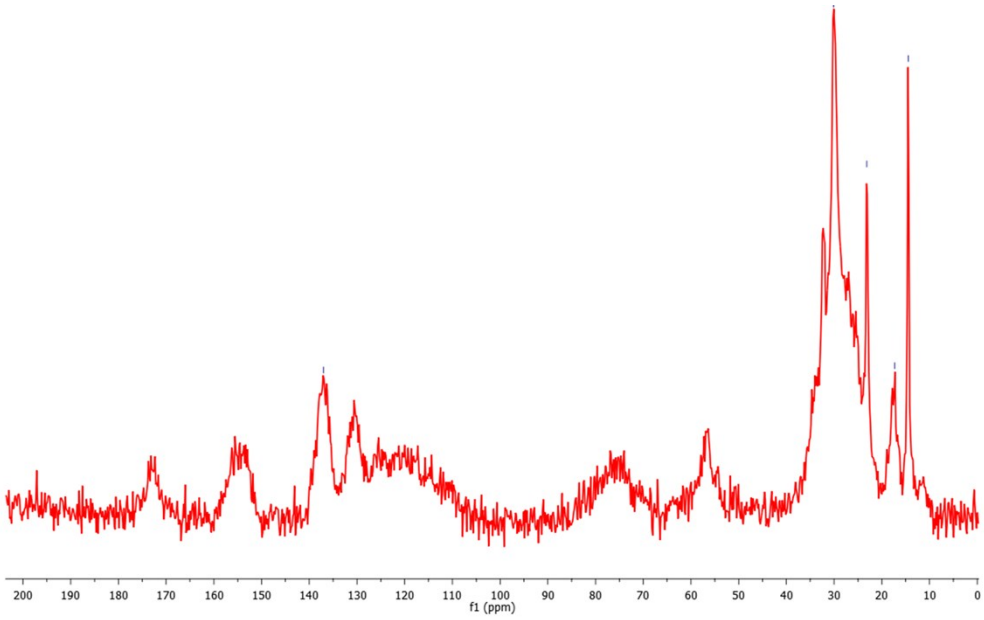

Fig. S1 ^{13}C NMR spectra of CD@PCz/PU nanocomposite.

Physicochemical and physicomechanical Properties

The physicochemical (viscosity, specific gravity and refractive index) and physicomechanical properties (scratch hardness, impact resistance, and bending ability) are found to increase with the loading of nanoparticles in PU and follows the order of PCz/PU<CD/PU<CD@PCz/PU (Table S1-S2). The enhanced mechanical properties of CD@PCz/PU nanocomposites are mainly due to the excellent dispersion, strong interfacial interaction and nanoscale morphology of CD and PCz. The bend tests showed good flexibility for all the coatings, as no cracks or ruptures were seen on the surface. This may be attributed to the presence of carbonized core structure and polar functional groups in CD help to provide stiffness and strong interactions with the PU matrix, resulting in improved mechanical properties [1]. Adhesion of the coatings with the CS substrate was measured by cross hatch test. The optical images clearly shows the cross and squares without any peeling off the coating (Fig. S2). The good adhesion of the coating is mainly due to the locking effect of nanoparticles with the polymer matrix.

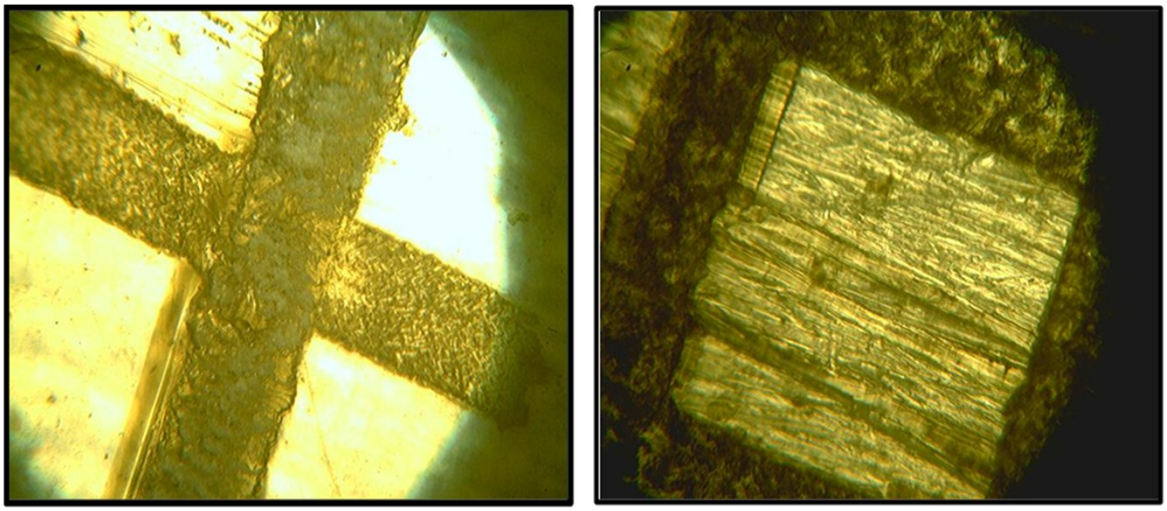

Fig. S2 Optical micrograph of CD@PCz/PU coating after cross hatch test.

Acid resistant test

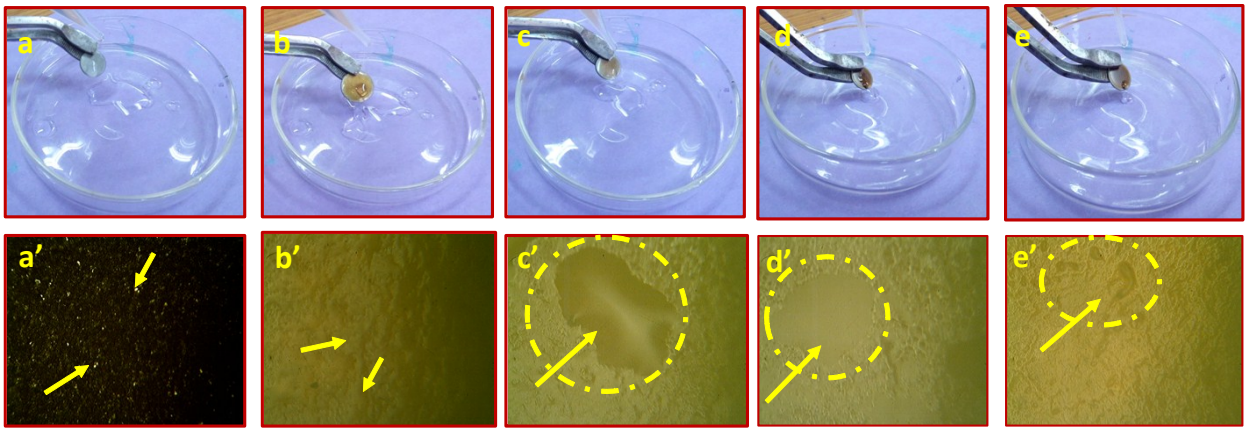

Fig. S3 Digital and Optical images after acid resistance test of CS (a, a'), PU (b, b'), PCz/PU (c, c'), CD/PU (d, d') and CD@PCz/PU (e, e').

EIS of bare CS and PU coating

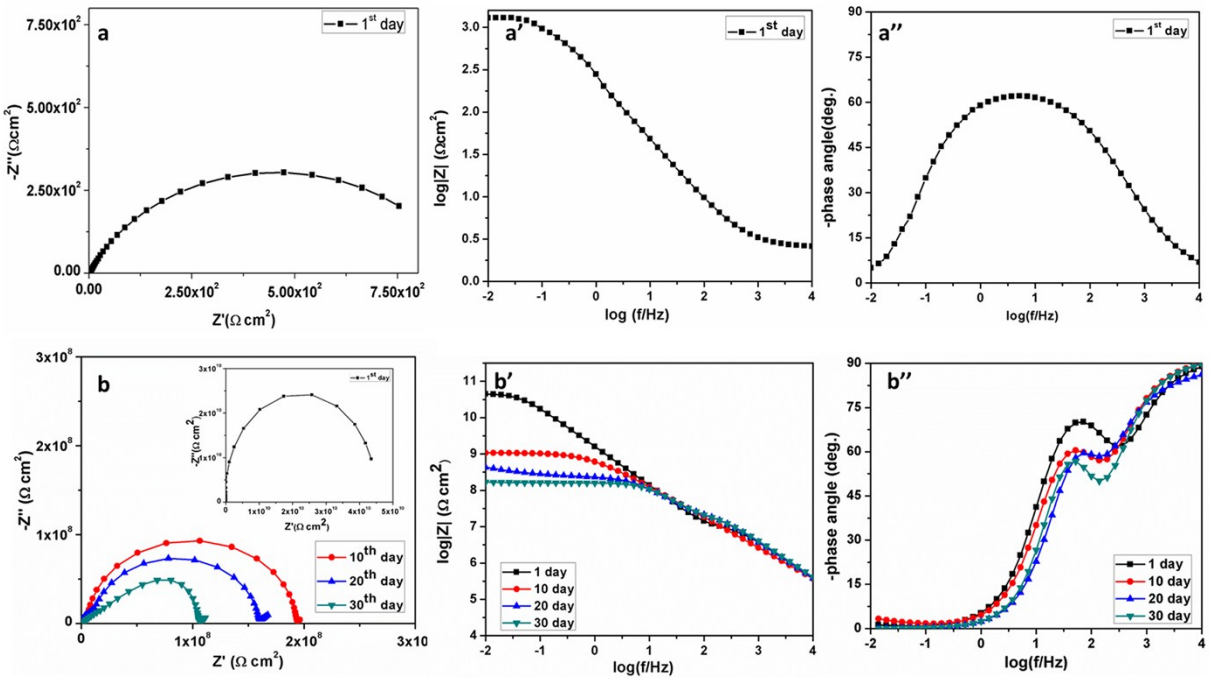

Fig. S4 Nyquist (a, b) and Bode plot (a', a''), (b', b'') of bare CS and plain PU respectively.

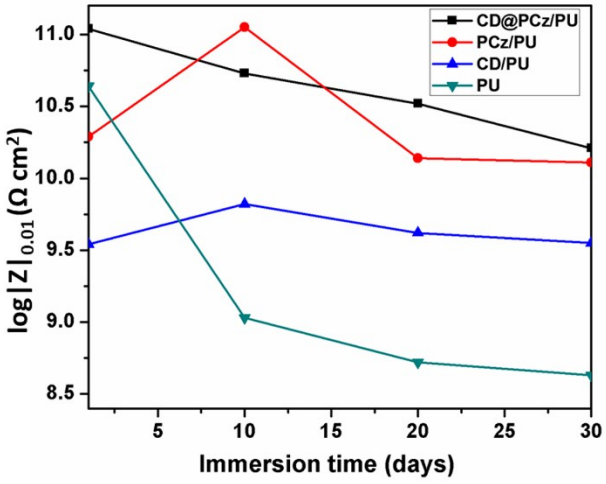

Fig. S5 Impedance value at $Z_{0.01}$ for PU, CD/PU, PCz/PU and CD@PCz/PU.

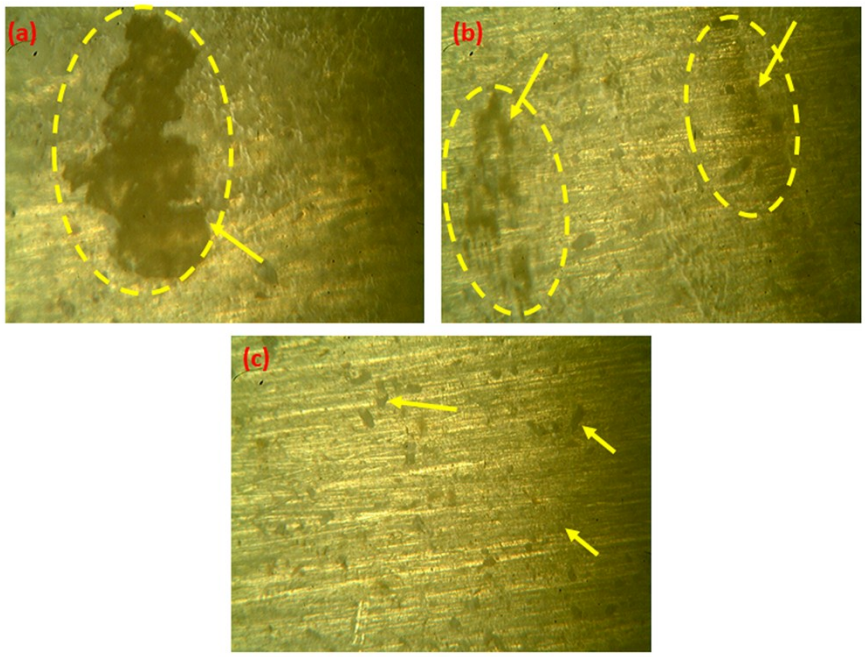

Fig. S6 Optical images of (a) PCz/PU, (b) CD/PU, and (c) CD@PCz/PU after corrosion studies (EIS and PDP).

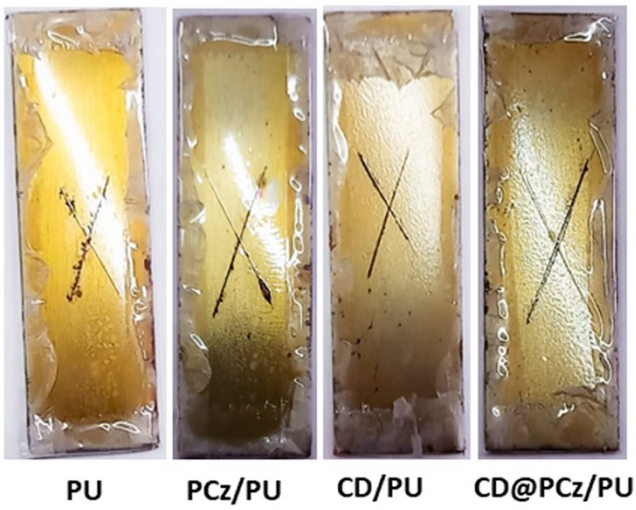

Fig. S7 Digital images of all the coated CS after salt spray test.

Table S1. Physicochemical properties of PU nanocomposite coatings

Resin Code	Inherent Viscosity (dL/dg)	Referactive Index	Specific Gravity
PCz/PU	1.012	1.501	1.44
CD/PU	1.030	1.491	1.46
CD@PCz/PU	1.120	1.489	1.47

Table S2. Physicomechanical properties of PU nanocomposite coatings

Resin code	Impact Resistance ($lb/inch^2$)	Scratch Resistance (Kg)	Bend Test (1/8□□)	Thickness (μm)
PCz/PU	250	6.67	Pass	90
CD/PU	250	6.98	Pass	92
CD@PCz/PU	250	7.21	Pass	92

Table S3. Comparison of various properties with our earlier reported work

S. No.	Coating system	Medium/ Immersion time	I_{corr} (Acm^{-2})	E_{corr} (V)	Corrosion rate (mpy)	*PE* (%)	Scratch Resistance (Kg)	Ref
1.	CD@PCz/PU	5 wt. % NaCl /30 days	1.15×10^{-11}	0.05	1.47×10^{-7}	99.999	7.2	Present work
2.	PDPA-V_2O_5/SFPU	5wt. % NaCl /30 days	7.45×10^{-11}	-0.040	8.66×10^{-7}	99.999	8.2	[2]
3.	POT/COPU	3.5 wt % NaCl/480 h	7.19×10^{-8}	-0.811	3.7×10^{-3}	99.76	8.2	[3]
4.	SMG-PU-TEOS-2	3.5 wt % NaCl/9 days	3.88×10^{-10}	0.01036	5.58×10^{-7}	-----	12	[4]

References

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4. A. Ghosal, O. U. Rahman, S. Ahmad, *Ind. Eng. Chem. Res.*, 2015, **54**, 12770−12787.