

Reversible and Highly Conductive Adhesive: Towards Self-Healing and Recyclable Flexible Electronics

Qiming Yan Meng Zhou Heqing Fu*

School of Chemistry and Chemical Engineering, Guangdong Provincial Key Lab of Green Chemical Product Technology, South China University of Technology, Guangzhou 510640, P.R. China;

*Corresponding author. Tel: +86 020 87114919; fax: +86 020 87112047.

E-mail: fuhq@scut.edu.cn .

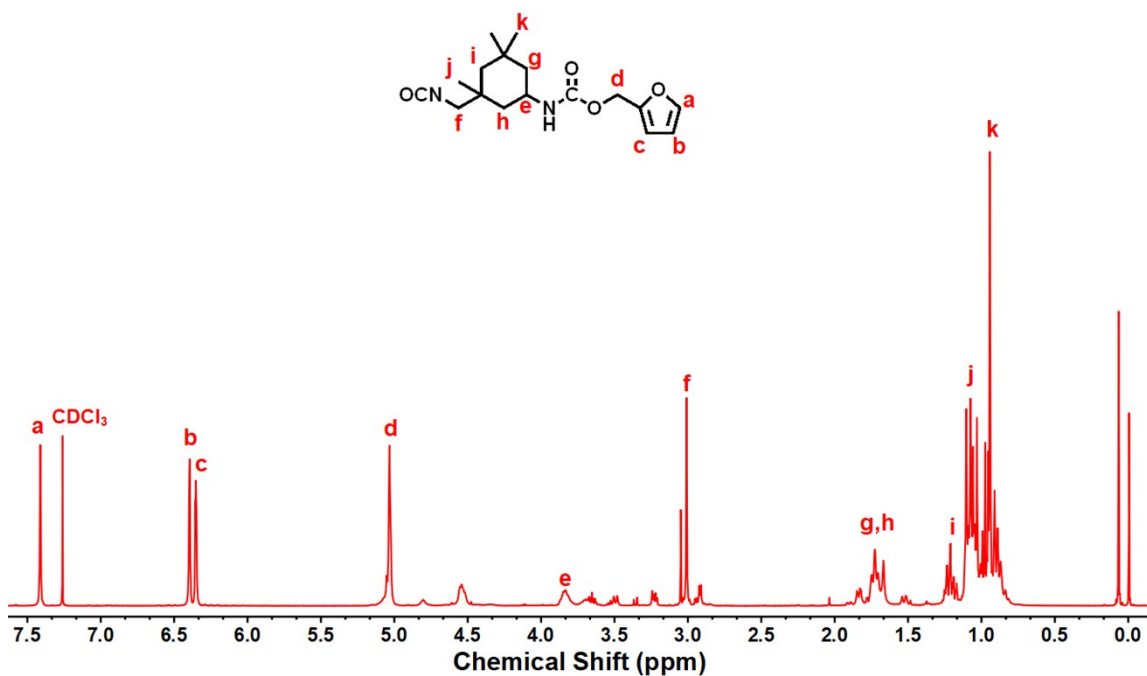


Figure S1. ¹H NMR spectrum of furan-based blocking agent in CDCl₃ (400MHz).

In the ¹H NMR spectrum of furan-based blocking agent, the peaks at 5.0~7.5 ppm correspond to the furan ring. The peaks at 0.9~3.9 ppm are

attributed to the IPDI alkyl unit[1].

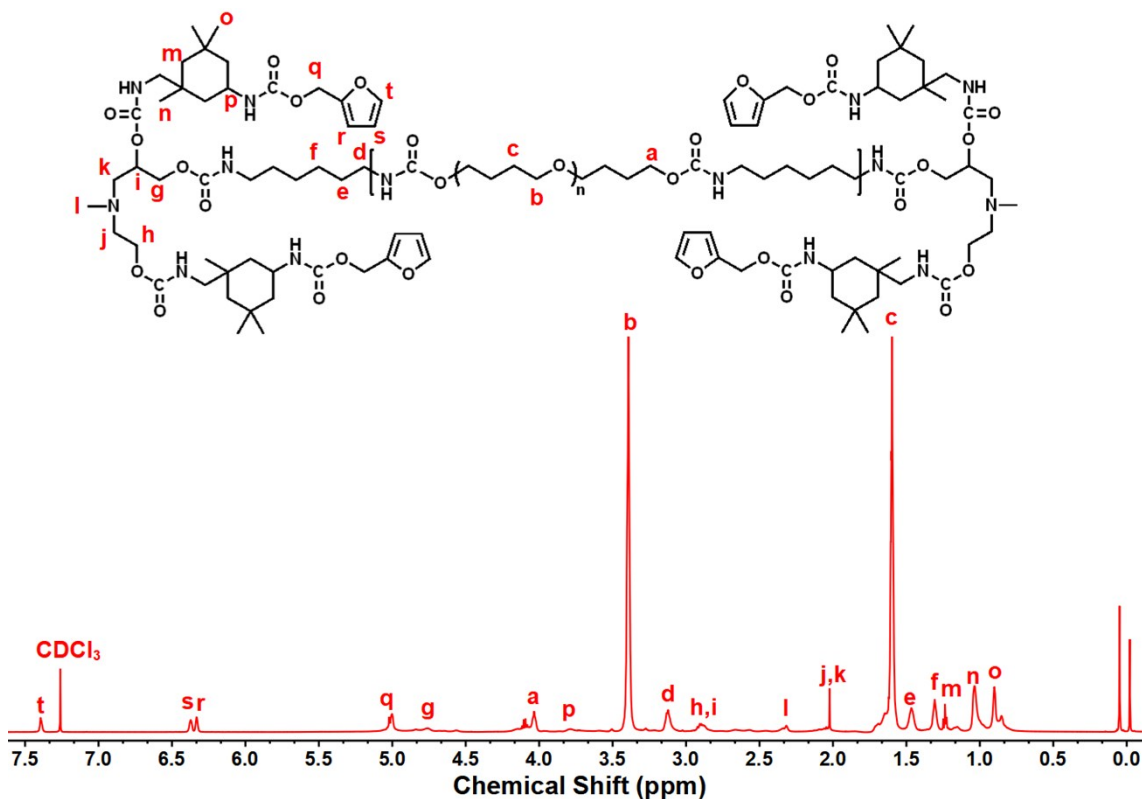


Figure S2. ¹H NMR spectrum of F4PU resin in CDCl₃ (400MHz).

Comparing to the ¹H NMR spectrum of furan-based blocking agent, the new peaks at 1.60, 3.39 and 4.03 ppm are assigned to the PTMEG unit, the peaks at 1.30, 1.46 and 3.12 ppm are attributed to the HDI unit, the peaks of 2-(methylamino) ethanol protons appear at 2.02~2.89 ppm, and the peaks of glycidol protons appear at 2.02, 2.89 and 4.76 ppm[2].

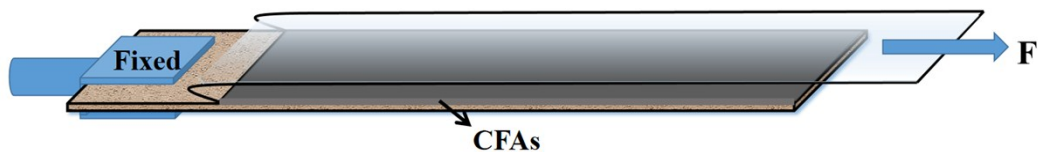


Figure S3. The model of 180° peeling test for RCFA.

Table S1. The loading amount of Ag nanoparticles and the conductivity of Ag@MWCNTs.

Samples	Ag@MWCNTs (0h)	Ag@MWCNTs (4h)	Ag@MWCNTs (8h)	Ag@MWCNTs (12h)
Ag concentration in DMF (original, wt%)	1.05	1.05	1.05	1.05
Ag concentration in DMF (after mixing, wt%)	1.05	1.03	1.01	0.98
Loading amount (wt%)	0	3.78	7.56	13.23
Electrical resistivity ($\times 10^{-2} \Omega \cdot \text{cm}$)	1.53 \pm 0.05	1.12 \pm 0.03	0.94 \pm 0.05	0.48 \pm 0.04

Table S2. Comparison of the self-healing behavior between RCFA samples and other self-healing materials.

Polymer	Type of dynamic bond	Self-healing Condition	Self-healing	Ref
PA	imine bond	room temperature for 24 h	~92%	3
SBR	boronic ester bond	80 °C for 24 h	>80%	4
	ionic hydrogen bond	room temperature for 12 h	~90%	5
	DA bond	120 °C for 20 min	>90%	6
PU	disulfide bond	room temperature for 24 h	97%	7
	carbon-carbon bond	50 °C for 24 h	~100%	8
	π - π interaction	room temperature for 12 h	~100%	9
PDMS	metal-ligand bond	room temperature for 48 h	~90%	10
	disulfide bond	UV for 48 h	~84%	11
PB	carbon-carbon double bond	room temperature for 1 h	~100%	12
EP	disulfide bond	60 °C for 1 h	~90%	13
PU	DA bond	NIR for 20 min	~92%	this work

Table S3. Mechanical Properties of Original and Self-healed RCFA^a

Samples	Original		Healed by heating			Healed by NIR		
	Ultimate strength	Break strain	Ultimate strength	Break strain	Self-healing efficiency	Ultimate strength	Break strain	Self-healing efficiency
	(MPa)	(%)	(MPa)	(%)	(%)	(MPa)	(%)	(%)
RCFA0	10.09±1.1	821±34	9.61±1.9	785±29	95.24	9.43±2.1	783±36	93.46
RCFA1	14.10±1.8	743±26	12.75±2.2	694±33	90.43	12.88±2.8	695±31	91.35
RCFA2	14.79±2.3	603±24	13.32±2.3	529±24	90.06	13.63±2.6	523±27	92.16
RCFA3	15.95±3.3	572±18	13.66±2.9	401±16	85.64	14.12±3.3	531±25	88.53
RCFA4	14.90±3.4	401±20	11.77±4.1	332±19	78.99	12.92±2.9	349±16	86.71

^aThe average values were obtained from more than 4 samples.

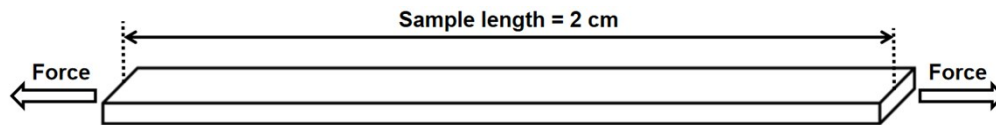


Figure S4. Schematic illustration of the stretching deformation.

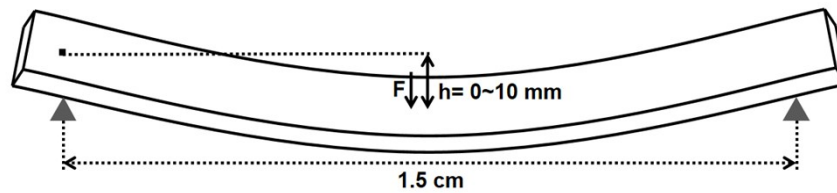


Figure S5. Schematic illustration of the bending deformation.

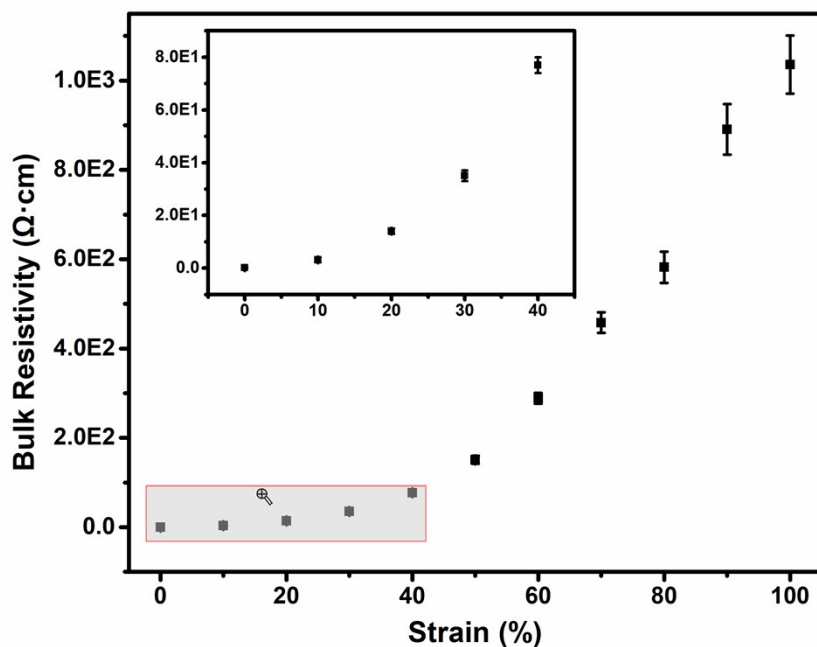


Figure S6. Electrical resistivity of RCFA filled with pristine MWCNTs and urea-g-MWCNTs under stretching deformation.

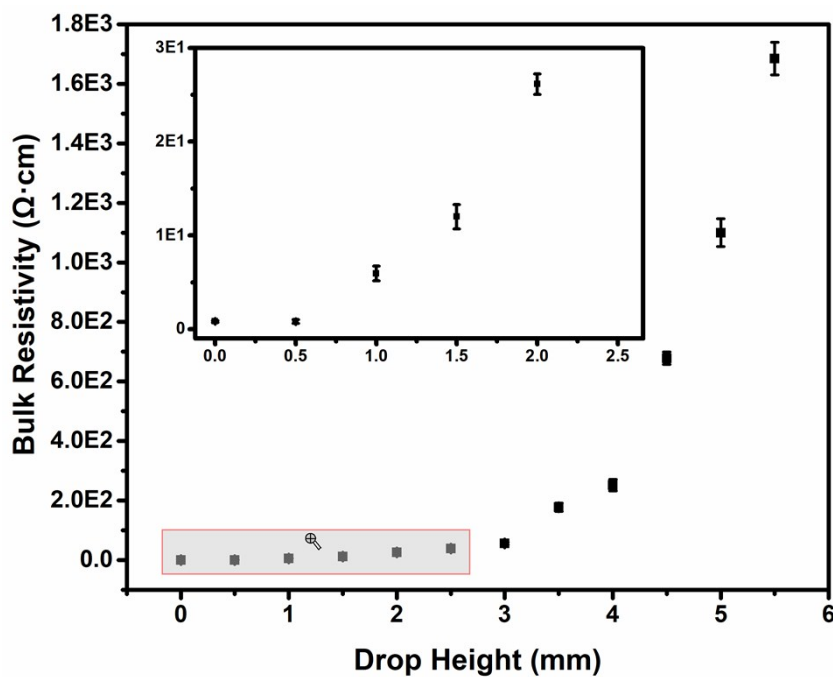


Figure S7. Electrical resistivity of RCFA filled with pristine MWCNTs and urea-g-MWCNTs under bending deformation.

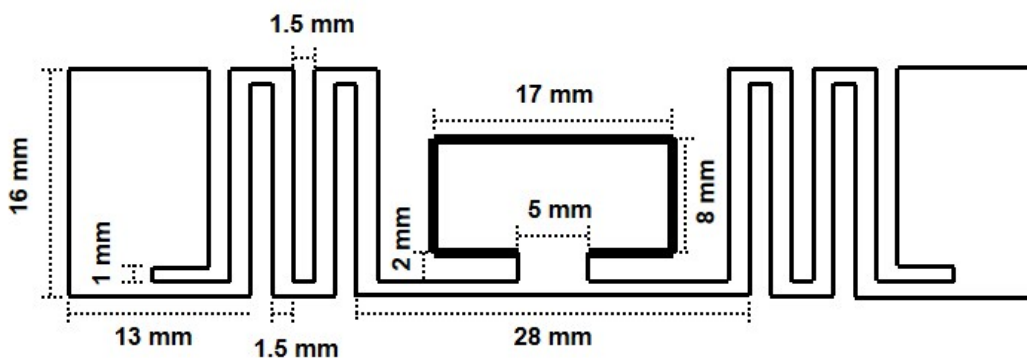


Figure S8. Geometry of RFID tag antenna.

The impedance value of Alien H3 RFID chip is $30-j110 \Omega$. Thus, we designed the antenna with the impedance value of $30+j110 \Omega$ so as to conjugate match with the chip[14].

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