Supporting information

Solvent-free electrically conductive Ag/ethylene vinyl acetate (EVA) composites for paper-based printable electronics

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Experimental Section

Weight percent selection of silver powders of solvent-free electrically conductive Ag/EVA composites

The reason why the loading of silver flakes was fixed between 40-70 wt% is as follow: Once the silver loading of Ag/EVA composites was 35 wt%, the volume resistivity of as-prepared, FAgL 6500 and FAgL6501 reached 0.82 Ω·cm, 16.8 Ω·cm and 36.9·Ω·cm, respectively. The volume resistivity increases by three orders of magnitude when compare with the Ag/EVA composites with the loading of 40 wt%. When the loading of silver surpass 70 wt%, electrical conductivity continues to deteriorate; furthermore, the production costs of them have been greatly raised; thirdly, the stirring of Ag/EVA composites becomes much more difficult; finally, the mechanical property of cured film of Ag/EVA composites deteriorate. Considering the electrical conductivity, mechanical property and production cost, the Ag/EVA composites filling with 40-70 wt% silver powders are chosen as the research subject. The electrical percolation of the three Ag/EVA composites are different, The electrical percolation of Ag/EVA composites filling with as-prepared flaky silver powders is around 25 wt%, of FAgl6500 and FAgL 6501 is about 30 wt%.

Table S1 The conversion relationship between weight fraction and volume fraction of solvent-free electrically conductive Ag/ethylene vinyl acetate (EVA) composites filling with different silver powders.

Name	Tap density (g/cm^3)	Weight percent (wt %)	Volume fraction (vol%)
As-prepared	4.3	40.0	13.4
		45.0	16.0
		50.0	18.9
		55.0	22.1
		60.0	25.9
		65.0	30.2
		70.0	35.2
FAgL 6500	3.0	40.0	18.2
		45.0	21.4
		50.0	25.0
		55.0	28.9
		60.0	33.3
		65.0	38.2
		70.0	43.7
FAgL6501	4.8	40.0	12.2
		45.0	14.6
		50.0	17.2
		55.0	20.3
		60.0	23.8
		65.0	27.9
		70.0	32.7

Note: The density of EVA is 1.0 g/cm^3.

Morphology of solvent-free electrically conductive Ag/EVA composites

Figure S1. Optical images of solvent-free electrically conductive Ag/EVA composites (filled with 55wt% as-prepared flake silver powders)

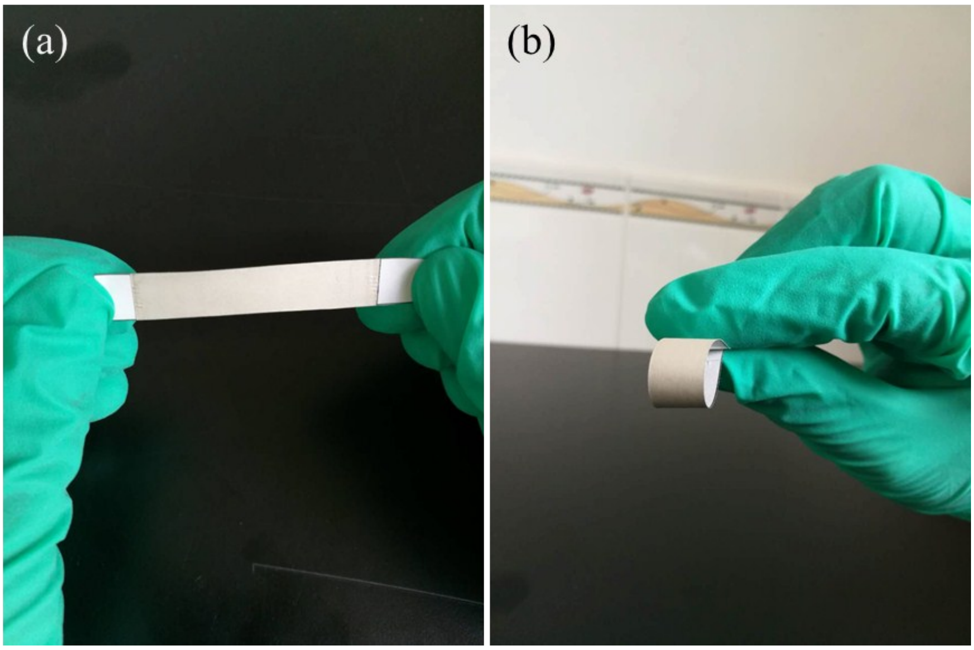

Figure S2 Cured conductive films of solvent-free electrically conductive Ag/EVA composites (55 wt% Ag) filling with as-prepared flake silver powders.

SEM micrographs of cured conductive films

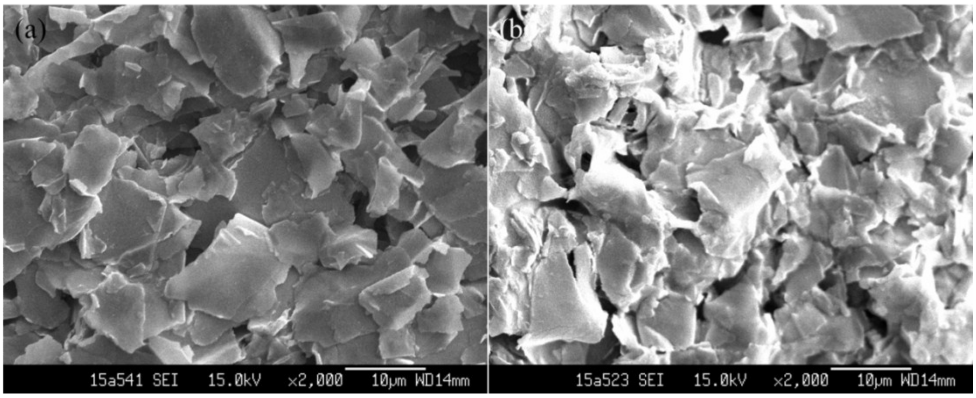

Figure S3 SEM of solvent-free electrically conductive Ag/EVA composites filled with as-prepared flake silver powder (a) 55 wt% Ag (b) 65 wt% Ag.

XRD analysis

X-ray diffraction was carried out to study the crystalline structures of the home-made and commercial silver powders. Figure S4 shows all the samples have four characteristic peaks for crystalline metallic silver at about 38.1°, 44.5°, 64.5°, 77.4° corresponding to the Bragg's reflection indices of (111), (200), (220), and (311) planes in a fcc structure, proving that all the silver powders haven't been oxidized.

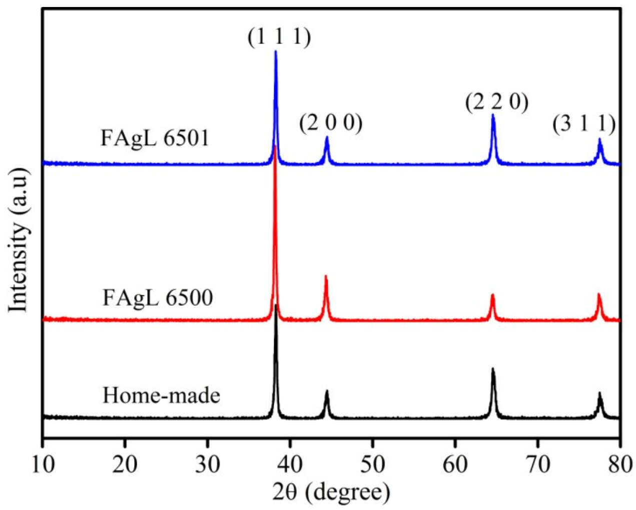

Figure S4 X-ray diffraction (XRD) patterns of flake Ag powders.

ATR-FTIR of paper substrate

It was observed that the peak at 880 cm^{-1} was assigned to C-H bending vibrations of glycosidic linkage.[1] The peak at 1055 can be corresponded to the C-O stretch of glucose ring. The peak at 1110 and 1160 cm^{-1} which could be associated to the -C-O-C- asymmetric stretch and vibration of glucose ring stretch in cellulose.[2] The Shoulder peak at 1343 and 1413 cm^{-1} were assigned to the asymmetric CH_2 bending and wagging.[3] The band appearing at 1632 cm^{-1} can be assigned to the conjugated C=O. The small peak which appeared at 1730 cm^{-1} can be attributed to the -C-O- stretching of the cellulose.[4] The band at 2902 cm^{-1} appeared due to C-H stretching in cellulose. The band at 3345 cm^{-1} can be ascribed to the stretching of H-bonded of -OH groups.[5]

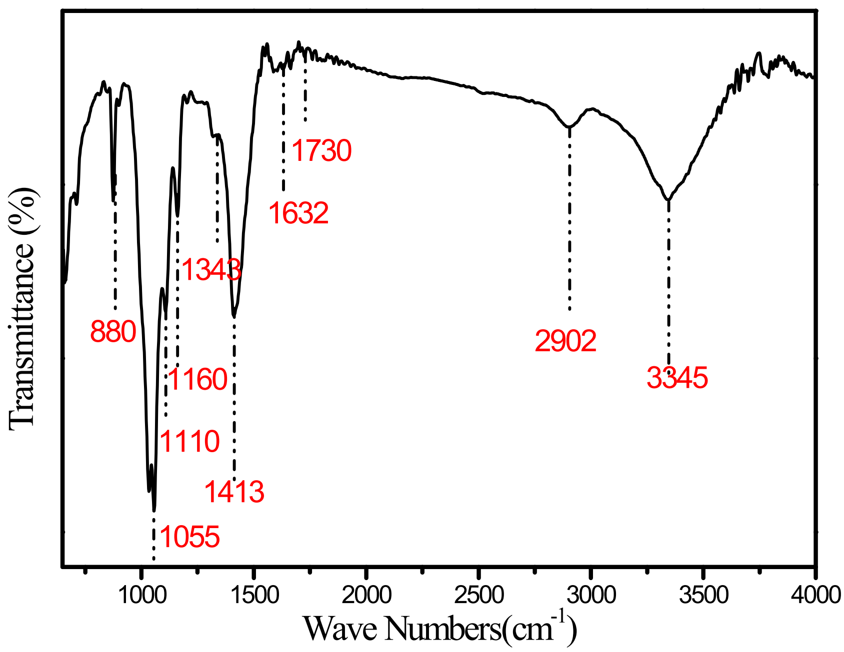

Figure S5 ATR-FTIR spectroscopy of paper substrate.

Adhesion test

From Figure S6(c) we can see that no noticeable conductive films were removed by the tape, a 5B level of adhesion strength was obtained. This can be ascribed to the excellent bonding of the conductive Ag/resin composites towards the paper substrate.

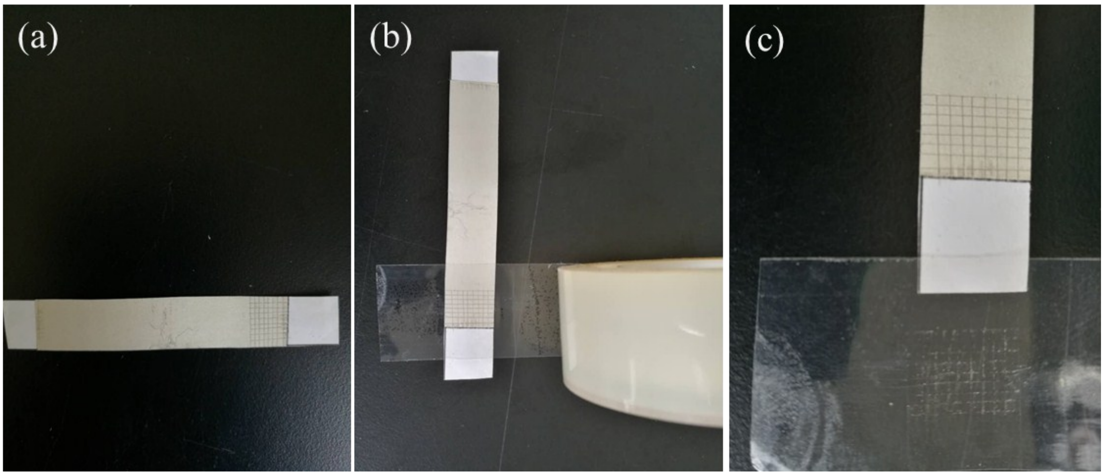

Figure S6 Optical images of (a) cured Ag/EVA conductive film after crosshatched; (b) the adhesion of conductive Ag/EVA film was testing by Scotch tape (3M); (c) the 3M tape after removed from the conductive film.

References

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