Supporting Information

Overcoming the Conductivity Limit of Insulator through Tunneling-Current Junction Welding: Ag@PVP Core-Shell Nanowire for High-Performance Transparent Electrode

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Tunneling effect

For tunneling effect in scanning tunneling microscope, the schematic diagram and detailed description are as following (**Fig. S1**). In quantum mechanics, even if the particle energy is lower than barrier energy, part of particle can still pass through the barrier. There seems to be a tunnel in the barrier. Hence, this phenomenon is called tunneling effect. Scanning tunneling microscope (STM) is designed from this effect (**Fig. S1**). In STM, the conductive sample is used as an electrode and the other electrode is a very sharp probe. When the distance between sample and probe is only several nanometers, although the probe and the sample have no direct contact, tunneling current will generate because of tunneling effect.

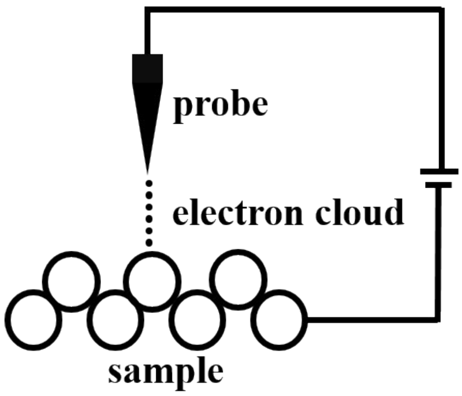


Fig. S1 The schematic diagram of tunneling effect in scanning tunneling microscope.

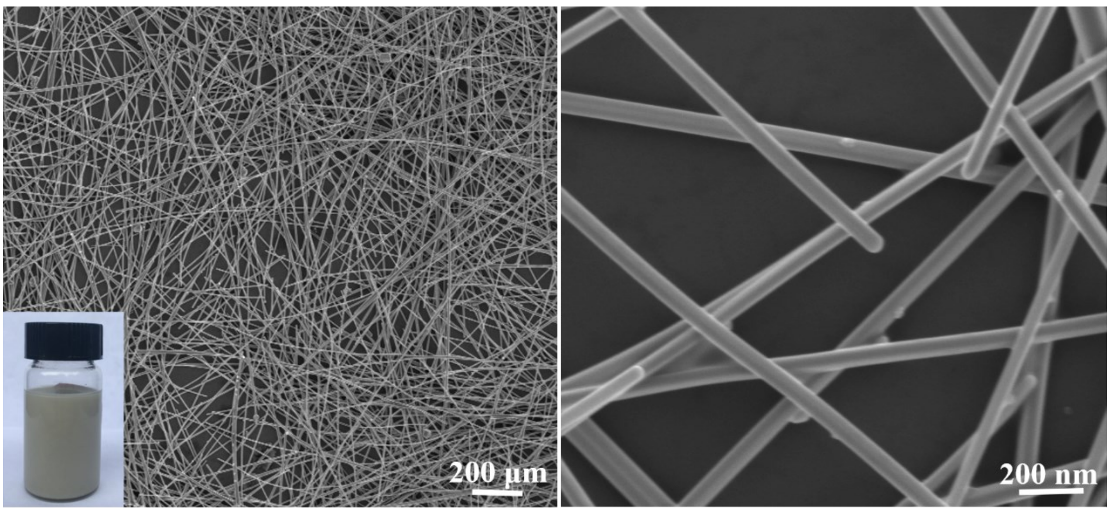


Fig. S2 The SEM images of AgNW used in this work (inset: photo of AgNW in ethanol).

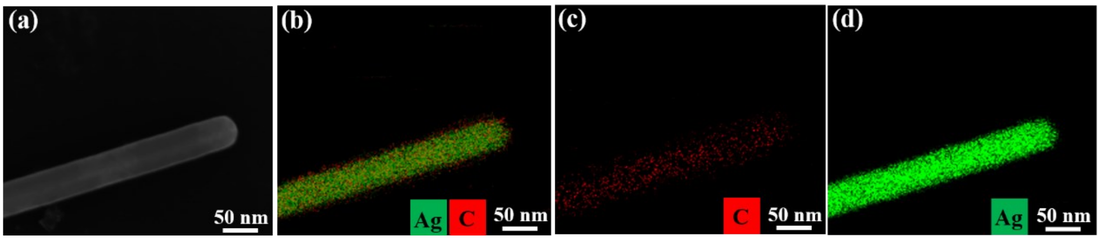


Fig. S3 The EDS mapping images of initial silver nanowire showing the elemental distributions of silver, carbon and the combination of these two elements (green for silver and red for carbon).

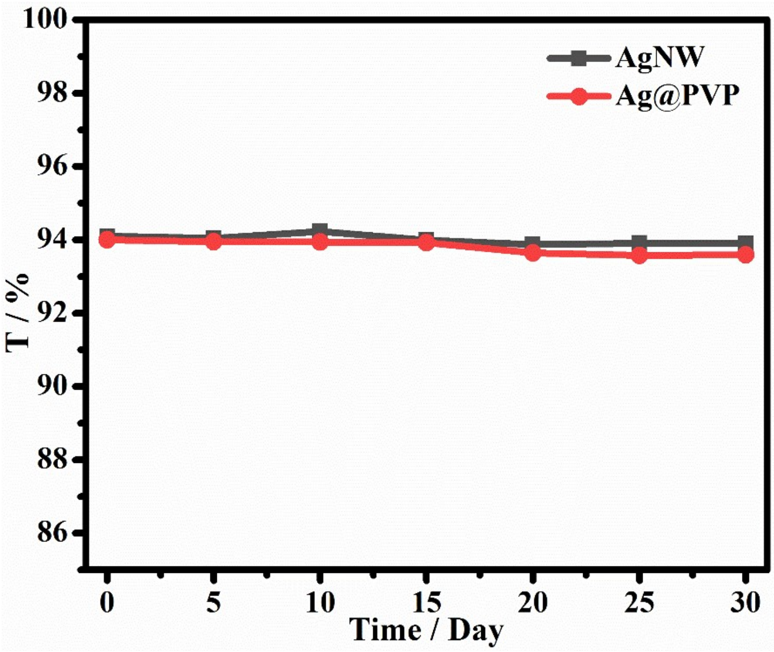


Fig. S4 The transmittance versus exposed time curves of AgNW and Ag@PVP films which are exposed to air with a constant relative humidity of 85% at 85 °C.

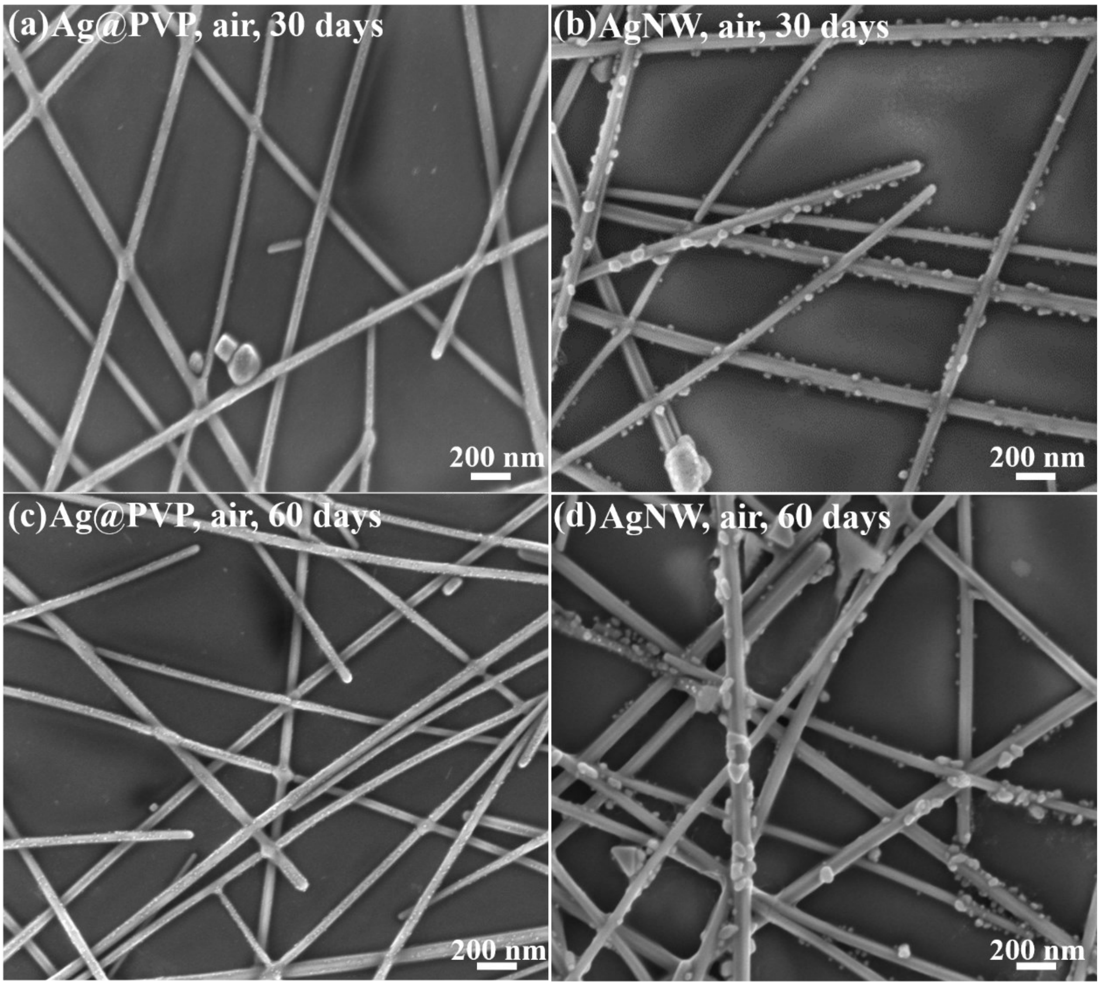
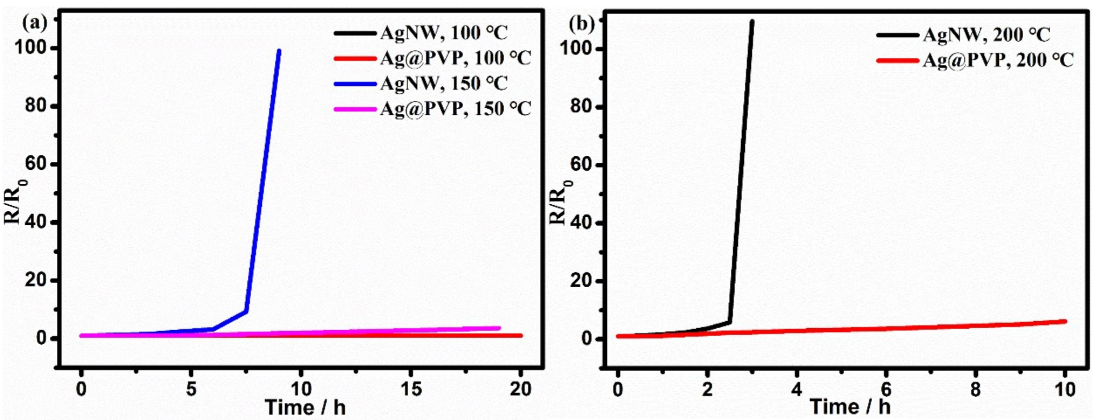


Fig. S5 The SEM images of (a) Ag@PVP film and (b) AgNW film after exposed to ambient condition for 30 days. The SEM images of (c) Ag@PVP film and (d) AgNW film after exposed to ambient condition for 60 days.



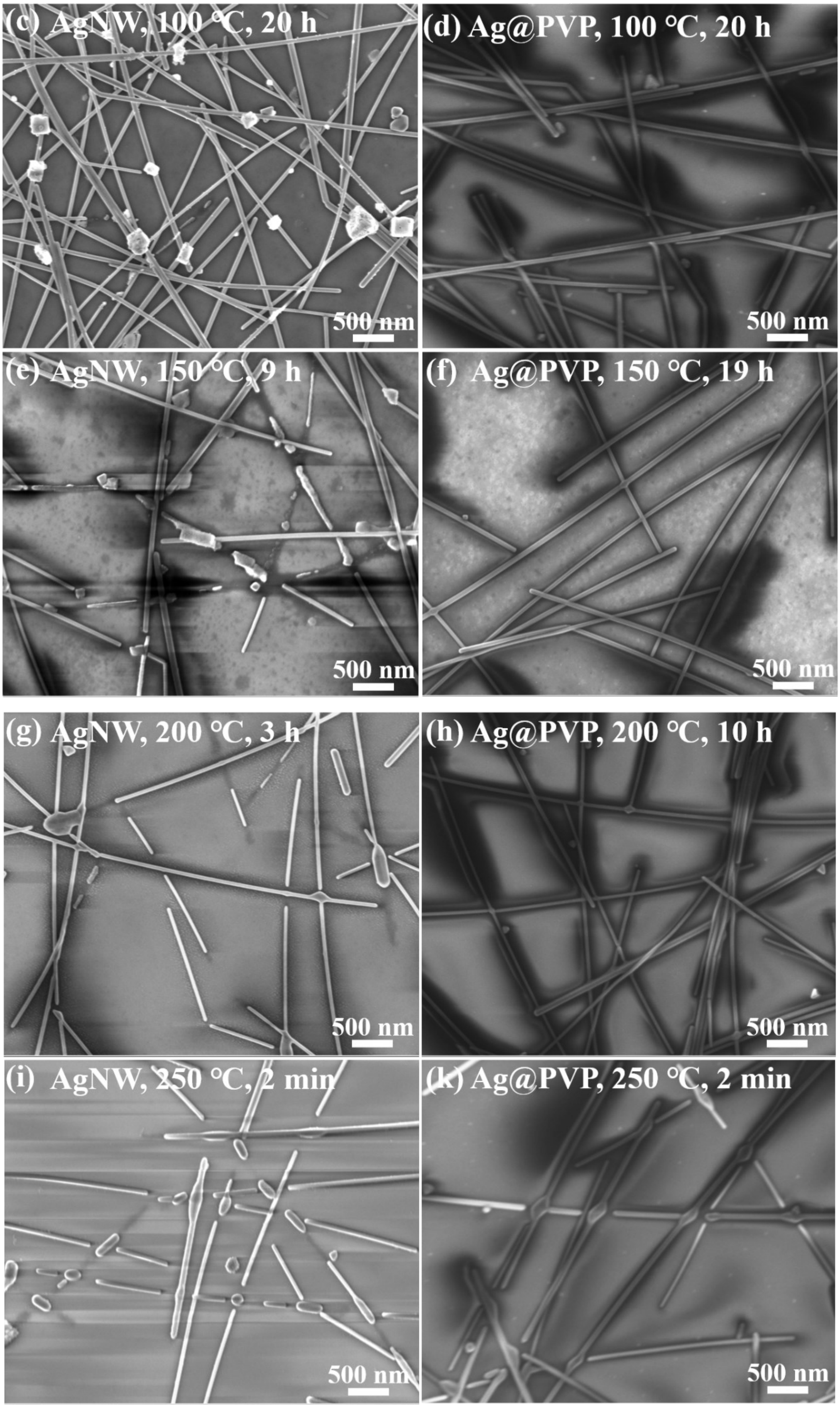

(c) AgNW, 100 °C, 20 h
500 nm
(d) Ag@PVP, 100 °C, 20 h
500 nm
(e) AgNW, 150 °C, 9 h
500 nm
(f) Ag@PVP, 150 °C, 19 h
500 nm
(g) AgNW, 200 °C, 3 h
500 nm
(h) Ag@PVP, 200 °C, 10 h
500 nm
(i) AgNW, 250 °C, 2 min
500 nm
(k) Ag@PVP, 250 °C, 2 min
500 nm

Fig. S6 (a-b) The sheet resistance change versus heating time curves of AgNW and Ag@PVP films which are heated at different temperatures (100, 150, 200) (R_0: the sheet resistance of freshly prepared film; R: the sheet resistance of film heated at different conditions). The SEM images of AgNW film heated at different conditions: (c) 100 ℃, 36 h; (e) 150 ℃, 9 h; (g) 200 ℃, 3 h; (i) 250 ℃, 2 min. The SEM images of Ag@PVP film heated at different conditions: (d) 100 ℃, 36 h; (f) 150 ℃, 19 h; (h) 200 ℃, 10 h; (k) 250 ℃, 2 min.

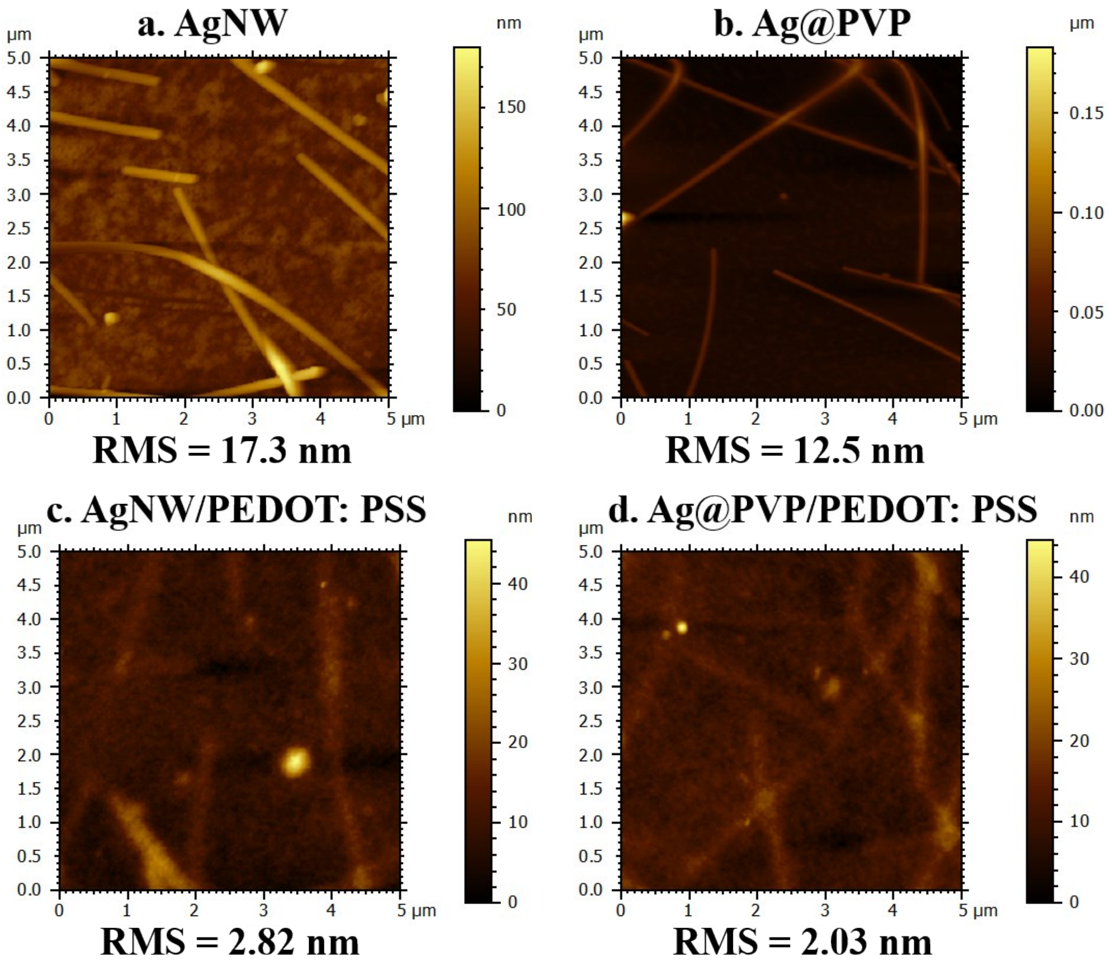


Fig. S7 The AFM images of AgNW film, Ag@PVP film, AgNW/PEDOT: PSS film and Ag@PVP/PEDOT: PSS film.

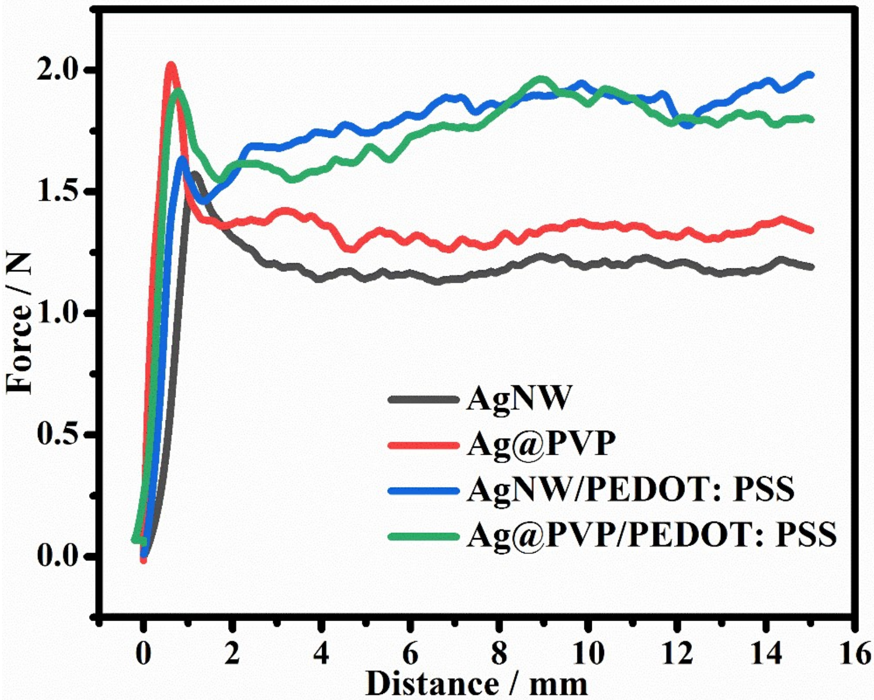


Fig. S8 The force-peeling distance curves for AgNW and Ag@PVP films before and after being covered by PEDOT: PSS layer on glass substrate.

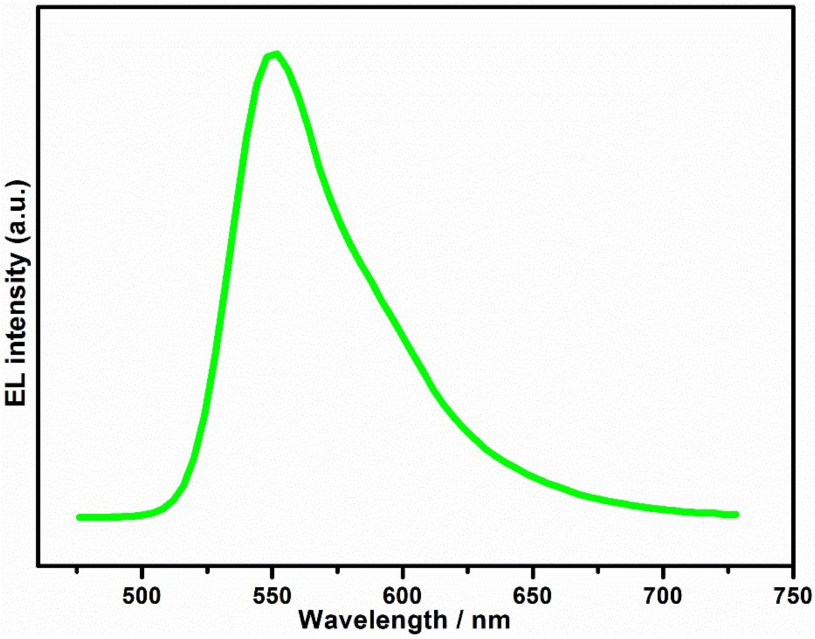


Fig. S9 The electroluminescent spectra of OLED device.