Electronic Supplementary Material (ESI) for RSC Advances.
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Supplementary Information

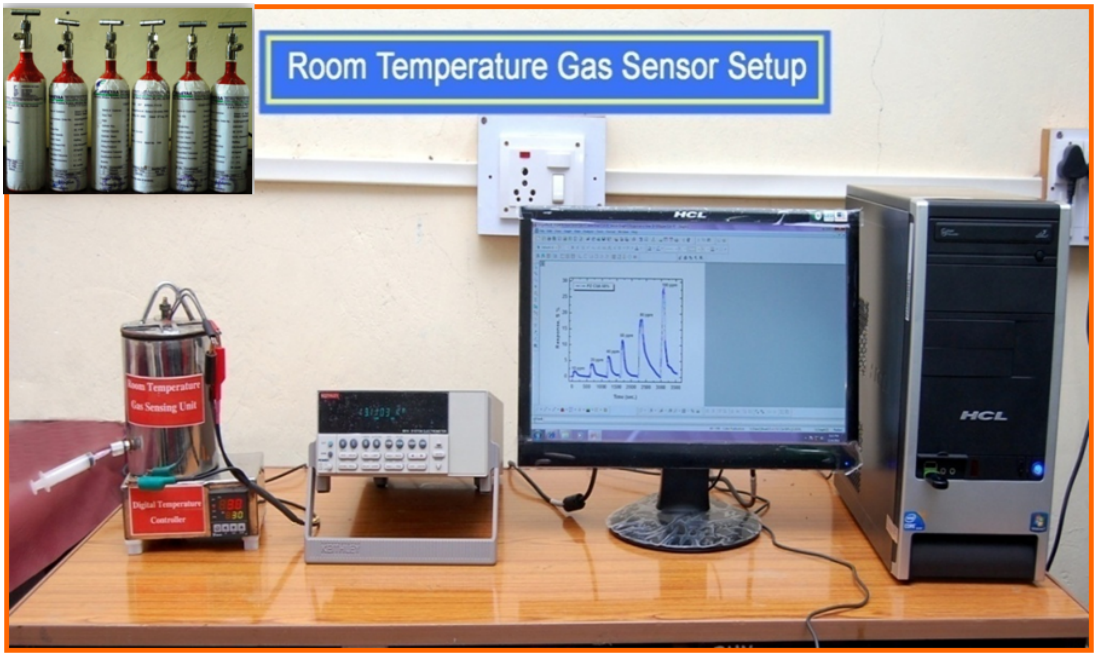

Fig.1. Experimental set up for room temperature gas sensing measurement.

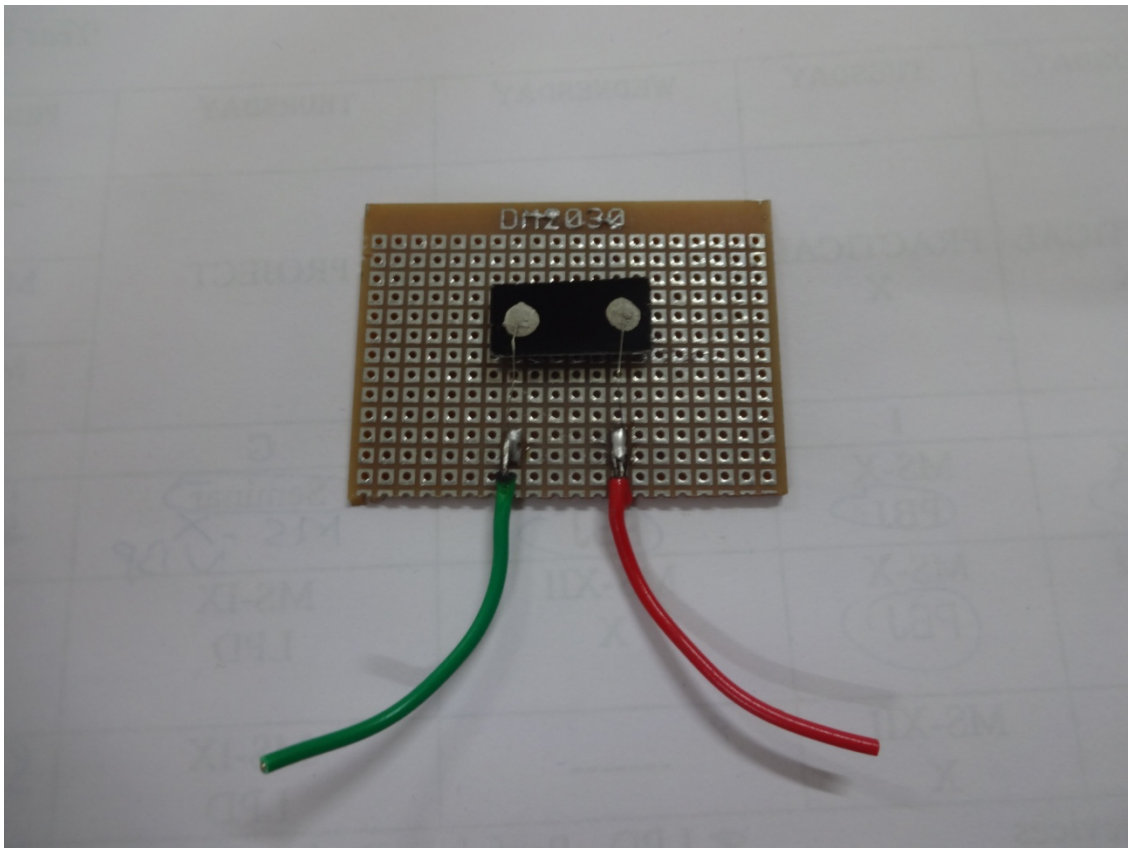

Fig.2. Photograph of CSA doped PPy/α-Fe_2O_3 hybrid sensor film .

FTIR analysis

The FTIR spectrum of the pure PPy, PPy/α-Fe_2O_3 (50%) and 30% CSA doped PPy/α-Fe_2O_3 hybrid nanocomposite are shown in Fig. 3. FTIR spectrum of pure PPy [Fig.3 (a)] shows the characteristic peaks at 792 cm^{-1} and 926 cm^{-1} are due to the C–H wagging as well as peak at 1049 cm^{-1} belongs to =C-H in plane deformation vibration. The characteristic peak at 1114 cm^{-1} attributed to C-H in and out of plane deformations and the N–C stretching band observed at 1204 cm^{-1}.While, =C–H in plane vibration observed at 1305 cm^{-1}. The peak observed at 1474 cm^{-1} and 1559 cm^{-1} are due to vibration of pyrrole ring and ring stretching mode of pyrrole ring respectively. C-N stretching vibration is observed at 1684 cm^{-1}.

The broad peak observed at 3117 cm^{-1} is due to N–H stretching. The observed different characteristic peak assignments in FTIR spectrum confirms the formation of PPy and well matches with those observed in other studies [1-3]. In the FTIR spectra of PPy/α-Fe_2O_3 (50%) nanocomposite [Fig.3 (b)], the main characteristic peaks of pure PPy at 792 cm^{-1} shifted to 797 cm^{-1},926 cm^{-1} shifted to 930cm^{-1},1114 cm^{-1} shifted to 1116 cm^{-1},1204 cm^{-1} shifted to 1213 cm^{-1},1474 cm^{-1} shifted to 1477cm^{-1} , 1559 cm^{-1} shifted to 1563 cm^{-1} and 1684 cm^{-1} shifted to 1689 cm^{-1} respectively. Furthermore, the new peaks at 554cm^{-1} and 680 cm^{-1} belong to Fe-O bond stretching, which clearly indicate the presence of Fe_2O_3 in the polymer matrix. While, shift in the peak positions attributed to some chemical interactions between PPy and α-Fe_2O_3 nanoparticle. The FTIR spectra of 30% CSA doped PPy/α-Fe_2O_3 [Figure 3(c)] also show the same characteristic peaks that of PPy/α-Fe_2O_3 nanocomposite. However, the peak at 554 cm^{-1} and 680 cm^{-1} are shifted towards 560 cm^{-1} and 683 cm^{-1} respectively. Furthermore, peak at 797 cm^{-1} shifted to 790 cm^{-1}, 930 cm^{-1} shifted to 924 cm^{-1},1049 cm^{-1} shifted to 1045 cm^{-1},1477 cm^{-1} shifted to 1472 cm^{-1},1563 cm^{-1} shifted to 1560 cm^{-1} and 1789 cm^{-1} shifted to 1740 cm^{-1}. These shifts are due to the chemical interaction between CSA and PPy/α-Fe_2O_3 hybrid nanocomposite.

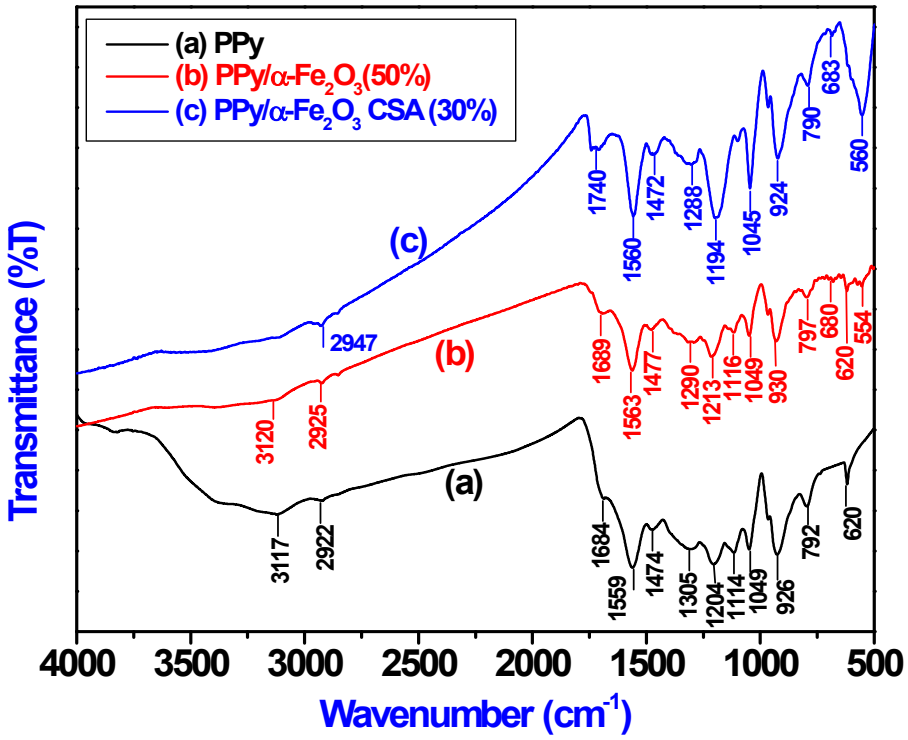

Fig.3. FTIR spectrum (a) PPy, (b) PPy/α-Fe_2O_3 (50%) and (c) 30% CSA doped PPy/α-Fe_2O_3 hybrid nanocomposite.

E-DAX analysis

The elemental presence of CSA doped PPy/α-Fe_2O_3 hybrid nanocomposite was analyzed by using energy dispersive X-ray (EDAX) spectroscopy and presented in Fig.4. E-DAX analysis confirms the existence of C, N, O, S and Fe elements in the deposited films and no noticeable impurity was observed. The detected element C, N and O are belongs to PPy and the element S belongs to camphor sulfonic acid. Furthermore, the Pt trace is due to the platinum coating applied to enhance the FESEM image.

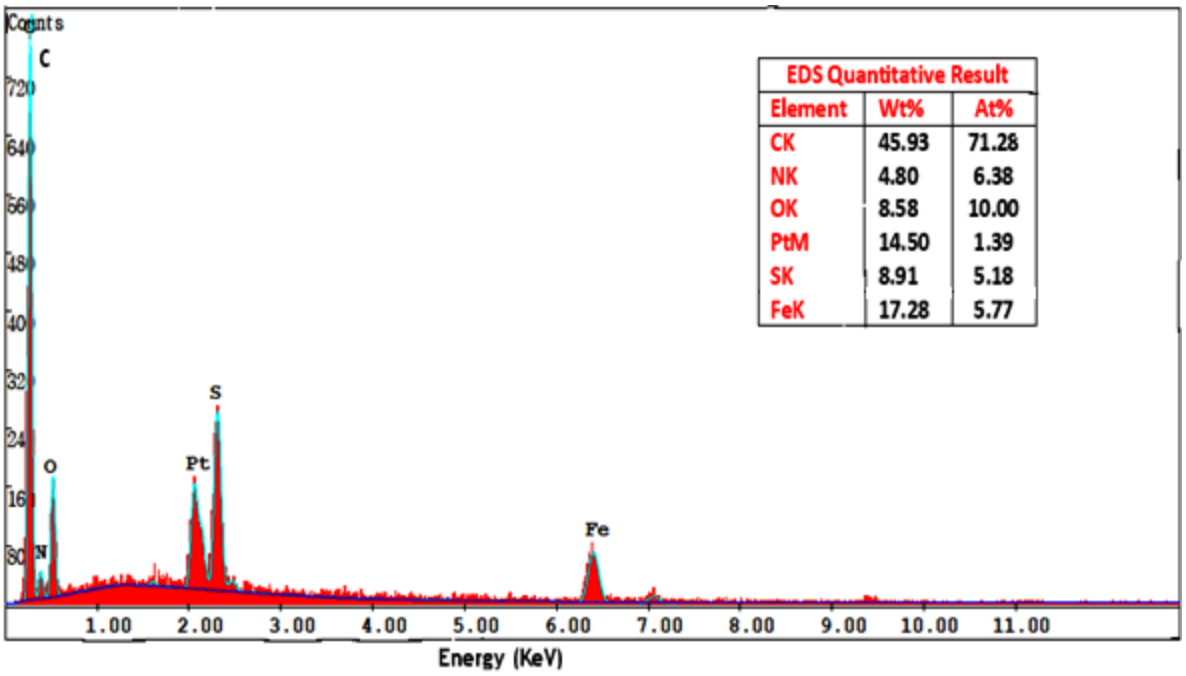

Fig.4. E-DAX spectrum of 30% CSA doped PPy/α-Fe_2O_3 hybrid nanocomposite.

XPS study

XPS is an effective technique to illuminate chemical state of the element and the surface composition existing in the prepared material. Therefore, the formation of CSA doped PPy/α-Fe_2O_3 hybrid nanocomposite was also confirmed by carrying out XPS analysis and the obtained XPS spectrum is shown in Fig. 5

The peaks C1s and N1s is located at the binding energies of 284 eV (C-C) and 399.82 eV (N-C) respectively, which are in good agreement with reported values of PPy [3].The two peaks Fe2p1 and Fe2p3 is located at 725.99 eV and 710.53 eV respectively with an energy difference of 15.46 eV, which is characteristic of Fe^{3+} state and confirms the presence of α-Fe_2O_3 in the prepared

hybrid nanocomposite [4]. The peak O1s at 531.43 eV indicates the presence of oxygen and matches with reported value [4]. While, S2p peak is found at 167.97 ev, which is due to dopant CSA. Thus, XPS results in addition to XRD and FTIR spectroscopy confirms the formation CSA doped PPy/α-Fe_2O_3 hybrid nanocomposite.

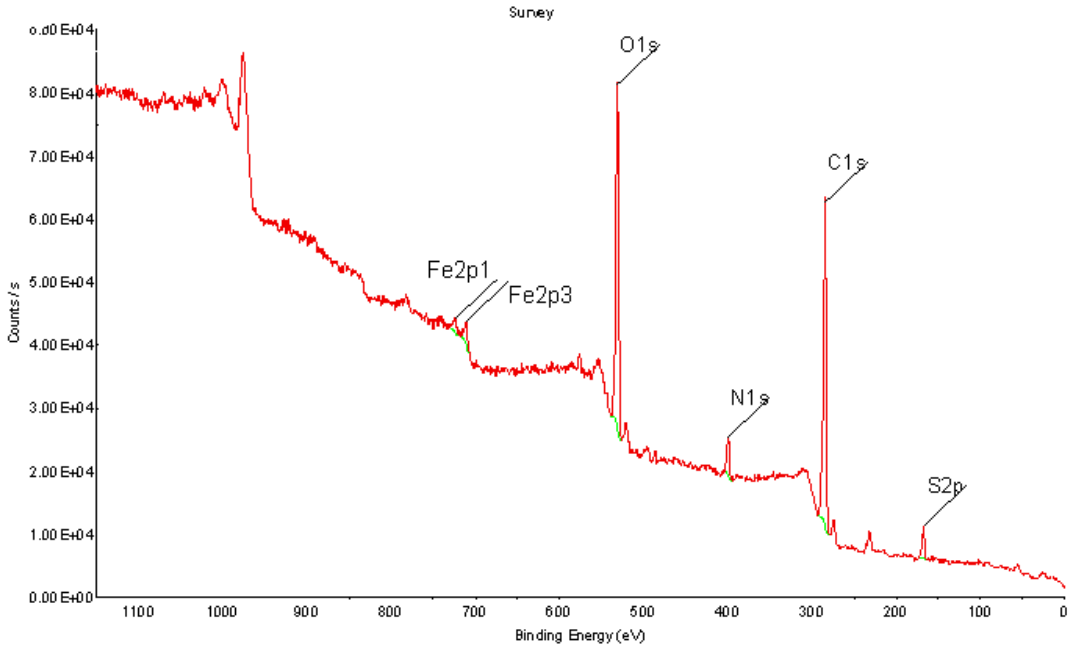

Fig. 5. XPS spectra of 30% CSA doped PPy/α-Fe_2O_3 hybrid nanocomposite.

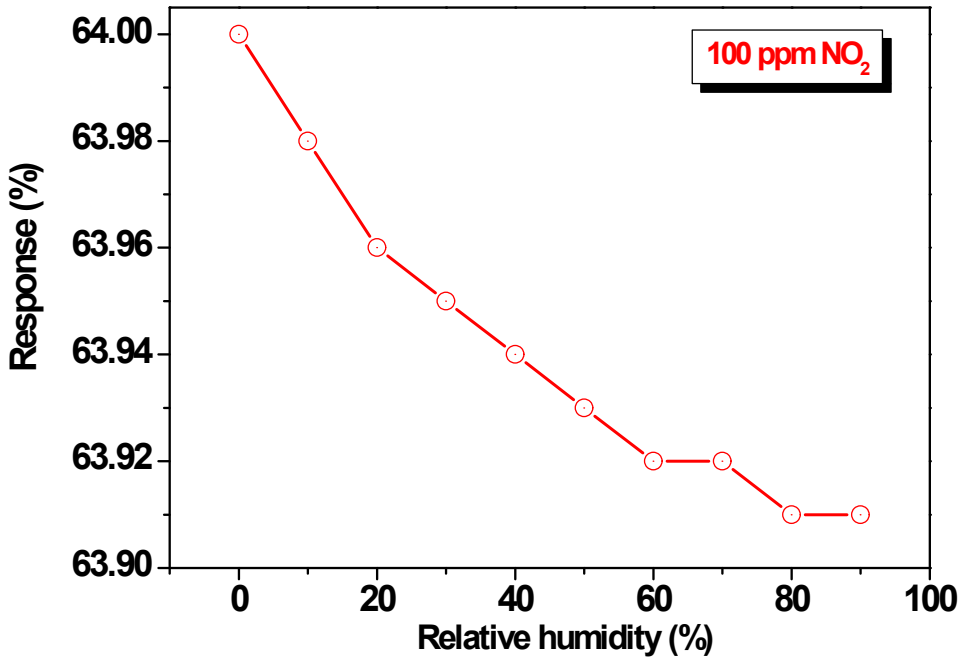

Fig. 6 . The variation of NO_2 response of CSA doped PPy/α-Fe_2O_3 film with 10-90% RH.

References

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