

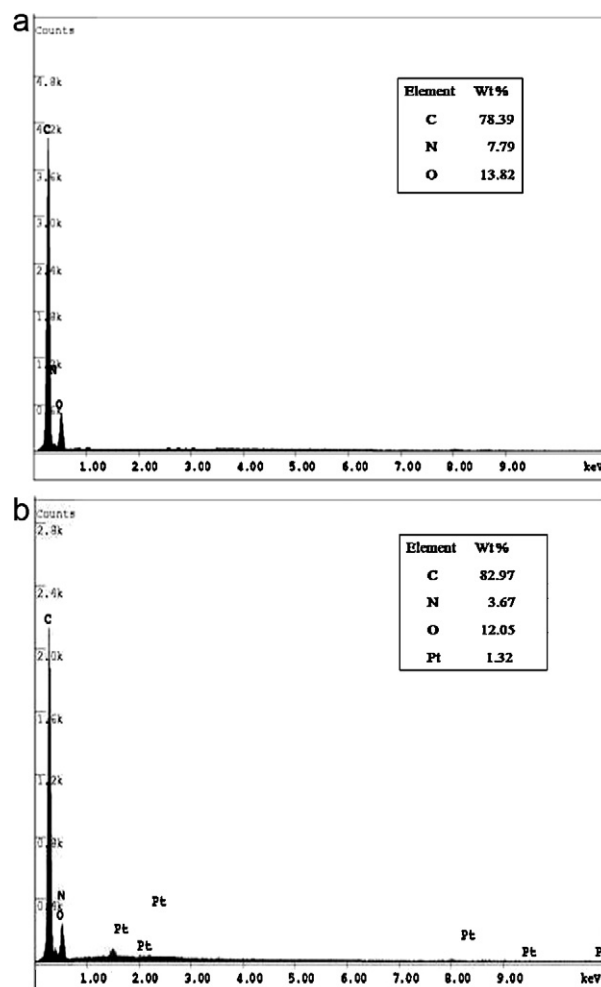
**Fig. 8.** TEM images of Pt/PANI composite depicting dispersion (a) and agglomeration (b).

peak corresponding to oxygen (O) highlights the following two points:

1. The porous structure of PANi facilitates water adsorption.
2. The doping of PANi by  $H^+$  ions from weakly ionized water holds the  $-OH$  ions as counter ions for charge balance.

This particular property doubles the functionality of PANi as the material with balanced hydrophilic characteristics also. As the aromatic ring backbone of PANi is well known for its hydrophobicity, its use in PEM fuel cell [40] is well suited to enhance performance.

Table 1 compares the platinum loading on the reference MEA and the sample MEA prepared and used in this study. It could be observed that the total loading of platinum is less in the sample MEA. With 1.32% of platinum in PANi as revealed by EDX,  $0.42 \text{ mg cm}^{-2}$  of the Pt/PANI used in the sample MEA, added  $5 \mu\text{g cm}^{-2}$  of platinum to the interlayer. Compared to the total loading of  $0.800 \text{ mg cm}^{-2}$  of the Pt in the reference MEA, the sample MEA has a total loading of  $0.675 \text{ mg cm}^{-2}$  of Pt and has a reduction in Pt by 18.5%.



**Fig. 9.** (a) EDX spectrum of PANi. (b) EDX spectrum of Pt/PANI composite.

Infrared (IR) spectra of PANi and Pt/PANI are shown in Fig. 10. The IR spectra for conducting polymers give information on the vibrational excitations of the materials and also the free carrier absorption and excitation, exciton transitions or light scattering by electron [41]. The assignment of the peaks of the IR spectra is given in Table 2. Due to the method of reduction of platinum(IV) ion on the PANi matrix, PANi may also get reduced affecting its conductivity. However protonation of PANi in fuel cell occurs spontaneously by the  $H^+$  ions from the anode reaction. The incorporation of platinum in the PANi matrix could change the corresponding vibrational frequency of the polymer. Charge transfer interactions between polymer chains and Pt nanoparticles have also been suggested [3]. Presence of water either as adsorbed species or held by ionic charge of the polymer matrix could also be observed from the IR spectra. The vibrational frequencies at  $786 \text{ cm}^{-1}$ ,  $2150 \text{ cm}^{-1}$  and  $3437 \text{ cm}^{-1}$  denote the stretching, bending and combination of both of them respectively of water molecule. While a general shift in all the vibrational frequencies have been observed by the inclusion of

**Table 1**  
Comparison of platinum loading in the reference MEA and the sample MEA prepared.

MEA	Pt loading ( $\text{mg cm}^{-2}$ )			
	Anode	Cathode	GDL	Total
Reference	0.30	0.50	–	0.800
Sample	0.23	0.44	0.005	0.675