3.1. Properties of TiO_2 nanoparticles

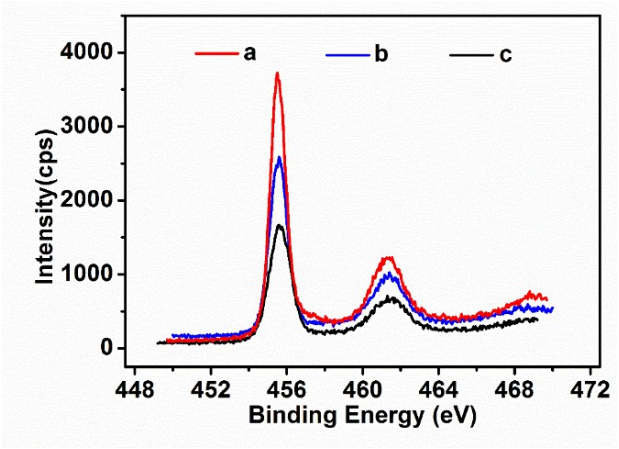

Fig. 1 XPS spectra for Ti 2p of a. TiO_2 purchased from Aladdin; b. TiO_2 synthesized from TBOT; and c. TiO_2 in the in-situ synthesized TFN membranes

The XPS image in Fig. 1 shows the Ti 2p spectra of TiO_2 NPs (Aladdin), TiO_2 NPs generated by TBOT hydrolysis, and TiO_2 in the in-situ TFN membranes. Generally, the binding energy of titanium dioxide is 458.7 eV at Ti $2p^{2/3}$ and 464.6 eV at Ti $2p^{1/2}$, which were similar to the values observed for each type of TiO_2 particle. As shown in Fig. 2, the peak values of the TiO_2 synthesized from TBOT and that in the in-situ synthesized TFN membranes were very close that of TiO_2 purchased from a commercial source, indicating that TiO_2 particles were produced from TBOT during membrane fabrication. The fixation of in-situ synthesized TiO_2 in the polyamide layer was very stable because of Ti^{4+} coordination and H-bonding between carboxyl groups and TiO_2 nanoparticles, which enhanced water flux while maintaining reasonable rejection performance.

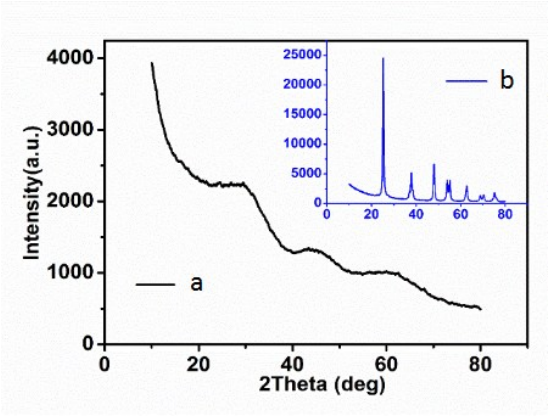

Fig. 2 XRD spectra of a. TiO_2 nanoparticles synthesized from TBOT and b.TiO_2 nanoparticles purchased from Aladdin

The crystal type of the TiO_2 nanoparticles was further confirmed by XRD analysis. TiO_2 synthesized in-situ from TBOT did not show an obvious characteristic peak, indicating that the TiO_2 in the TFN membranes was in an amorphous state. Crystal TiO_2 can be formed by high-temperature calcination, but the in-situ synthesis procedure only involved heating TiO_2 at 80 °C, so crystallization was not achieved. To the best of our knowledge,

only a few studies have reported that the type of TiO_2 used in the membrane synthesis process influenced membrane performance. For example, the effects of different types of nanocrystalline materials (including rutile and anatase) on the performance and antifouling properties of ultrafiltration and nanofitration membranes have been reported[1,2]. However, the effects of amorphous TiO_2 on membrane performance and other membrane properties have not been studied systematically.

1. V. Vatanpour, S. S. Madaeni, A. R. Khataee, E. Salehi, S. Zinadini and H. A. Monfared, *Desalination*, 2012, **292**, 19-29.
2. X. Cao, J. Ma, X. Shi and Z. Ren, *Applied Surface Science*, 2006, **253**, 2003-2010.