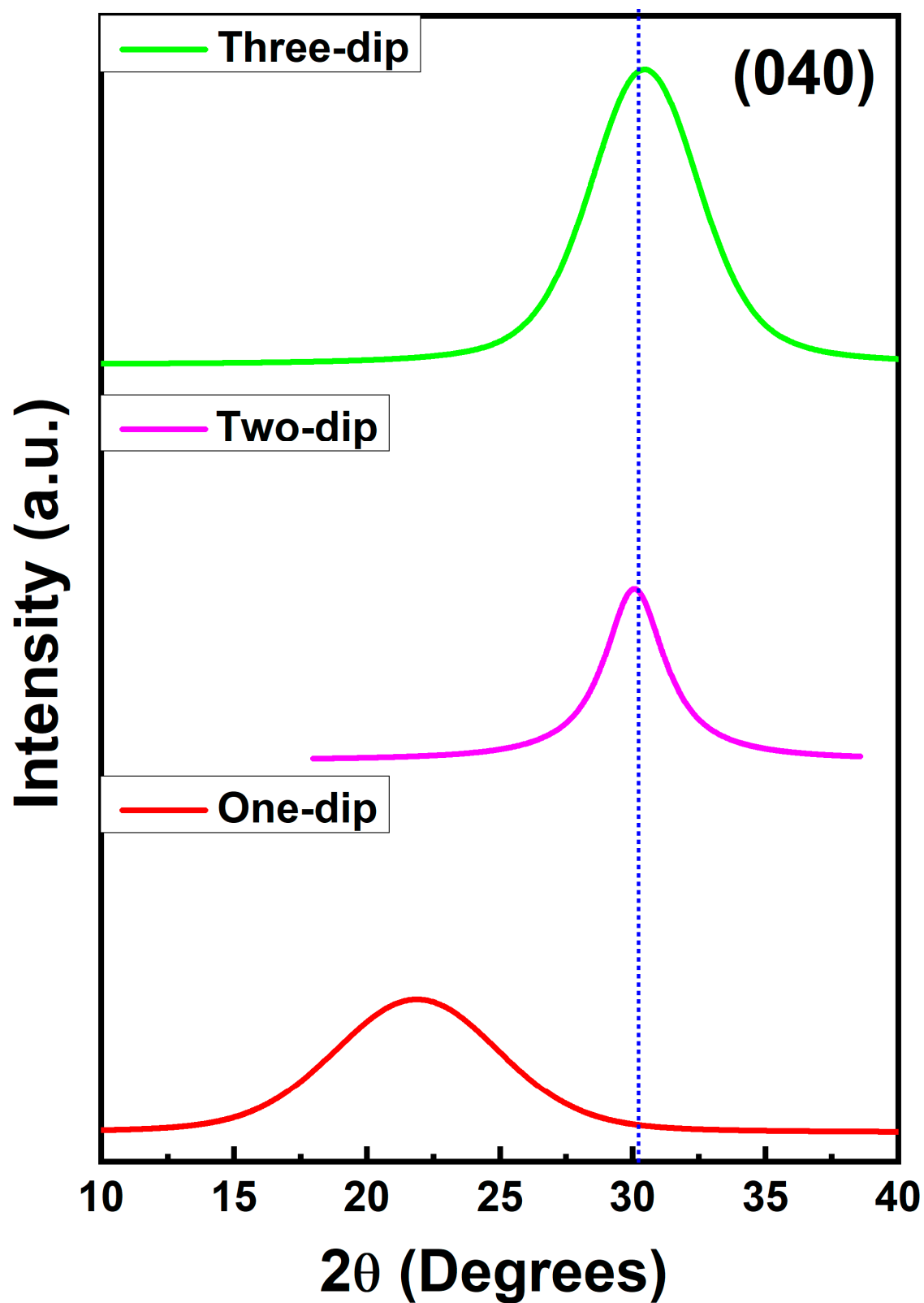
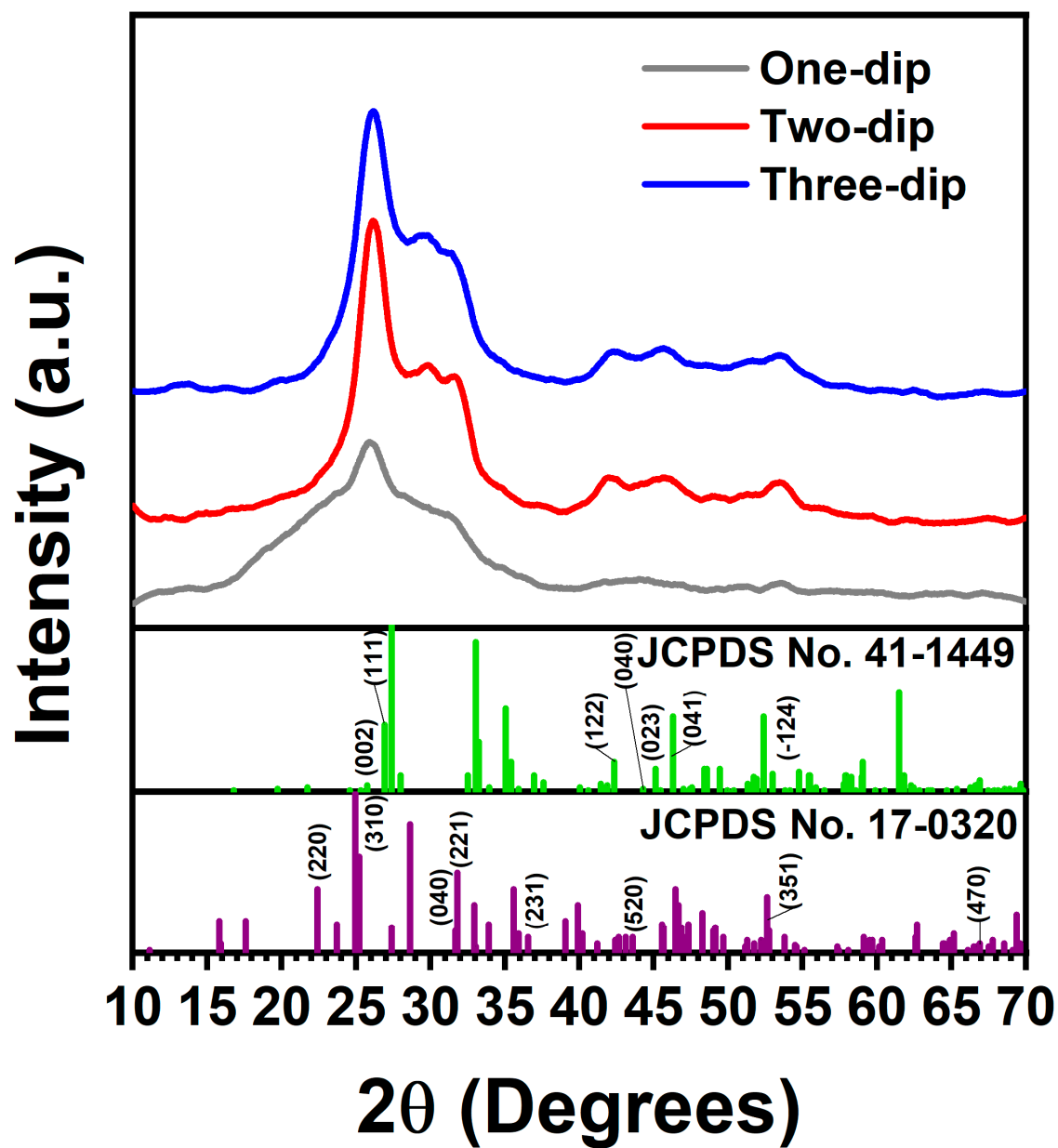
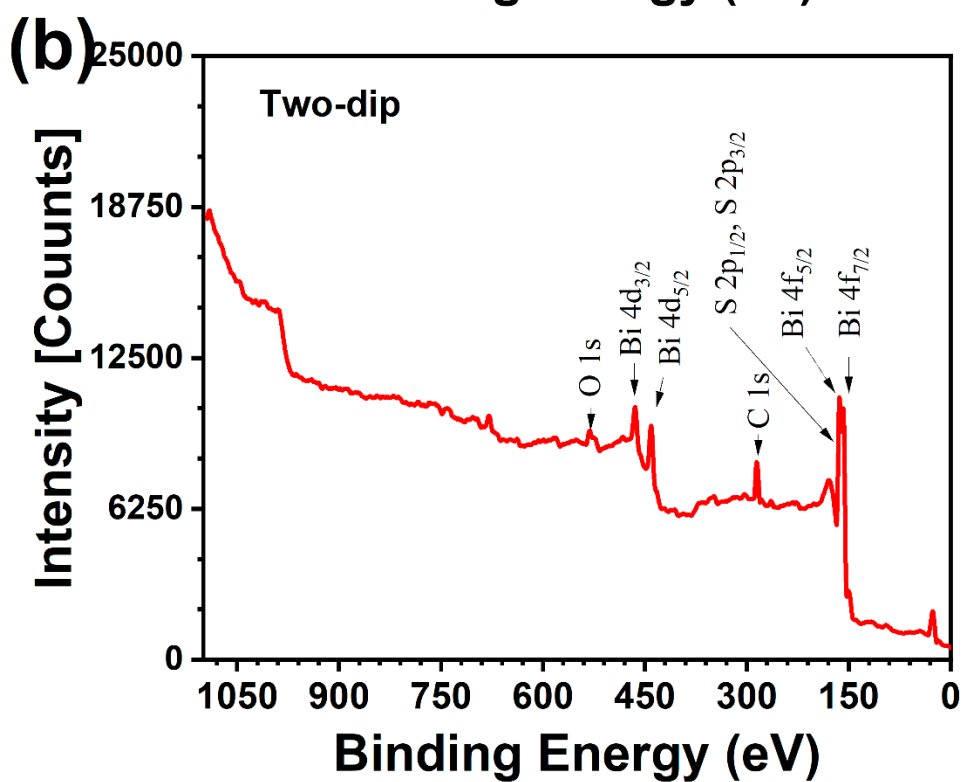
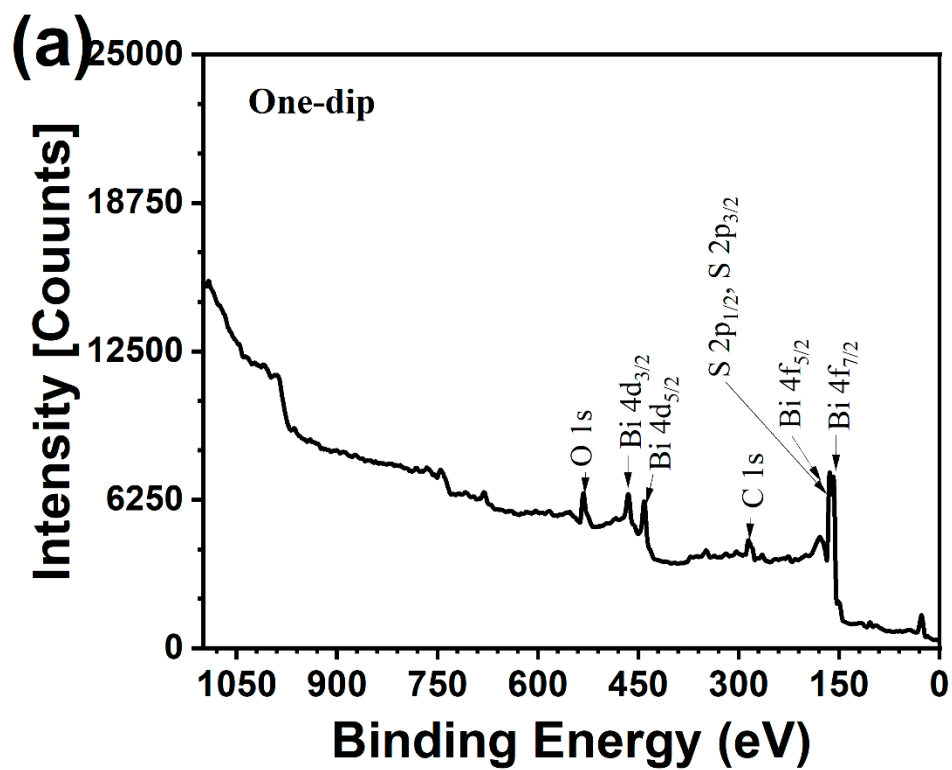




**Fig. S1.** Peak positions, peak shift, and peak broadening for the one-, two-, and three-dip thin films. The (040) plane is the preferred orientation.



**Fig. S2.** XRD patterns of Bi-based thin films matched with the corresponding diffraction planes from Powder Diffraction File (PDF) cards No. 41-1449 ( $\text{Bi}_2\text{O}_3$ ) and No. 17-0320 ( $\text{Bi}_2\text{S}_3$ ).



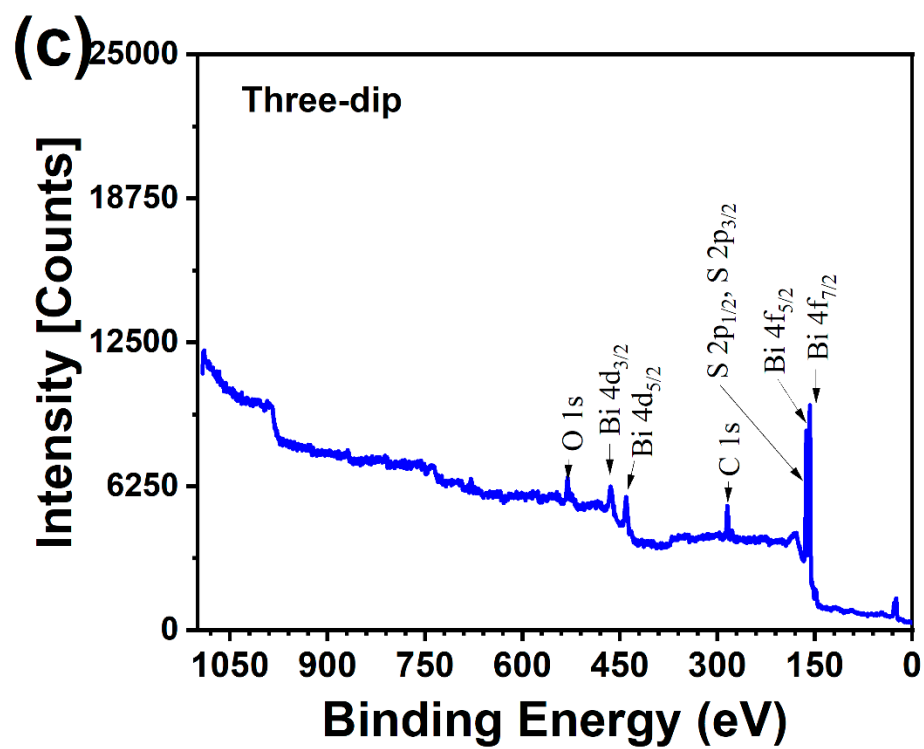


Fig. S3. XPS survey spectrum for Bi-based thin films.