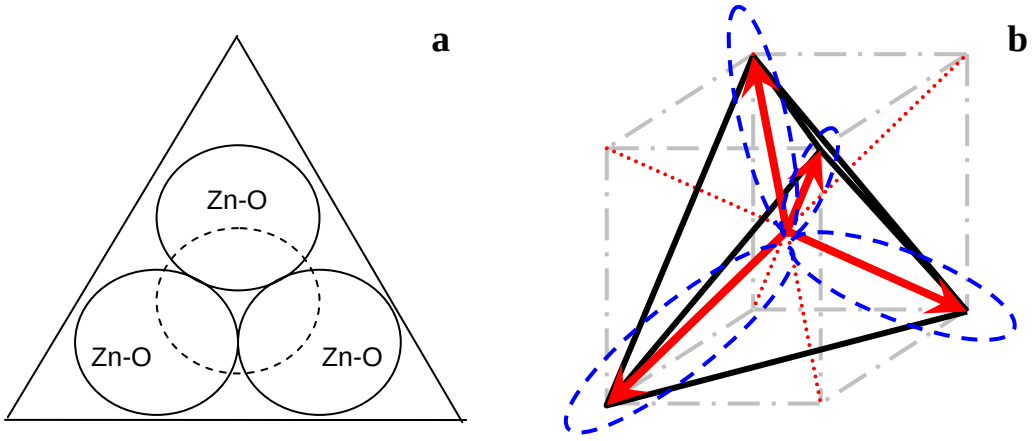

Figure 4.16 A schematic illustration of the pyramid growth of ZnO tetrapod. **a**) A schematic illustration of ZnO cluster. **b**) A schematic illustration of ZnO tetrapod growth model.

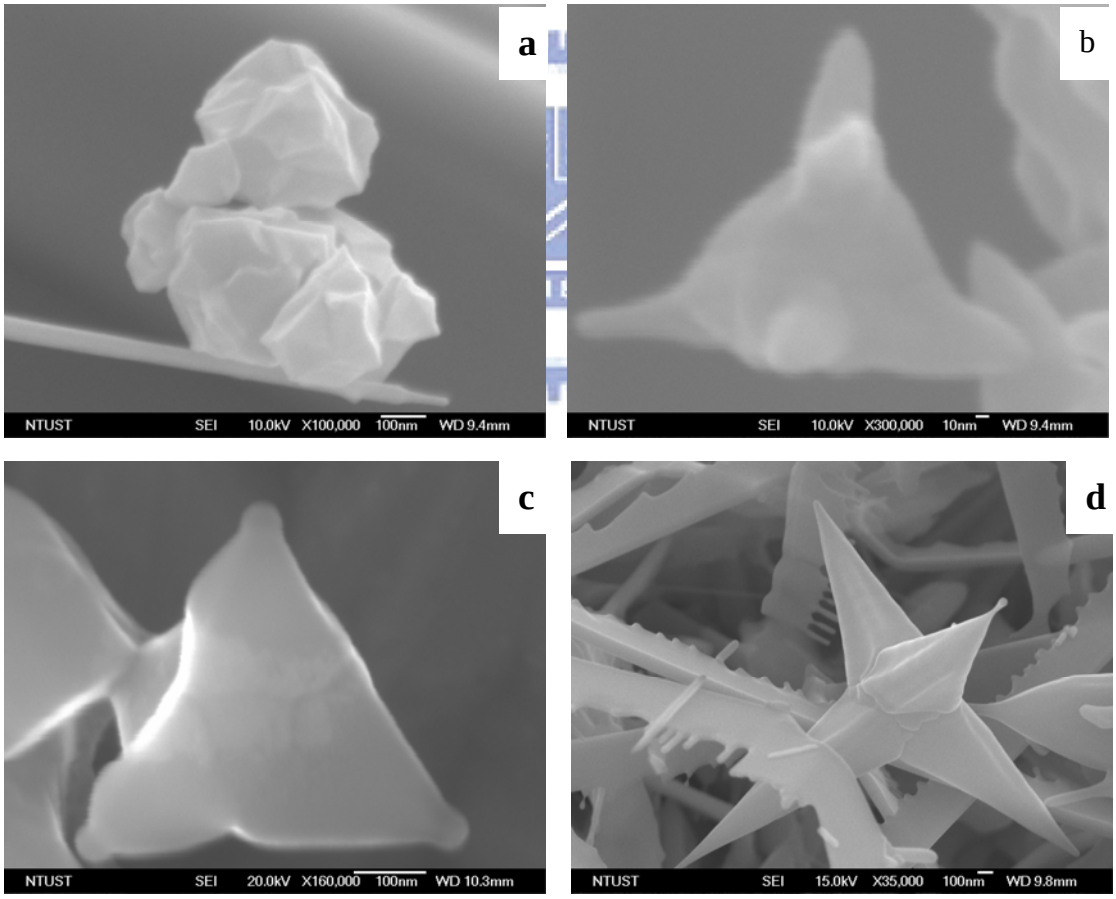

Figure 4.17 SEM images of ZnO tetrapods nucleus. **a**) A face-view image of ZnO cluster. **b**) High magnification, a face-view image of ZnO tetrapod nucleus starting to grow. **c**) A high magnification image of smaller “armor unit” shape T-ZnO. **d**) A face-on view of awl-shape ZnO tetrapod.

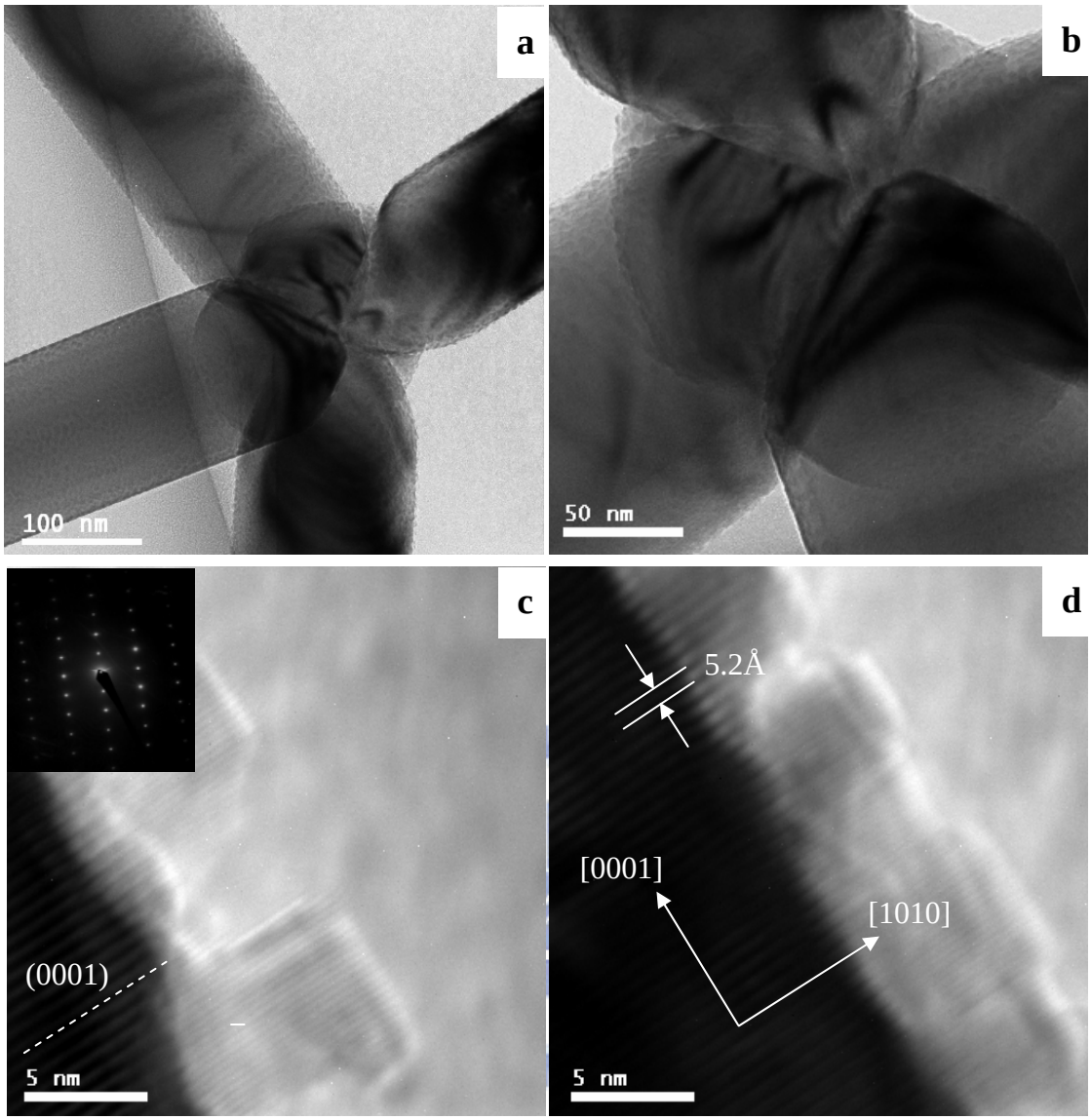

Figure 4.18 TEM micrographs of single T-ZnO nanorod. **a**) A low magnification TEM image of the single T-ZnO nanorod. **b**) An enlarged TEM image of the single T-ZnO nanorod in Fig.4.18**a**. **c**) A HR-TEM micrograph of the rim side of single T-ZnO nanorod. Inset in Fig. 4.18**c** is a $[\bar{1}2\bar{1}6]$ zone-axis diffraction pattern of its. **d**) A high magnification HR-TEM micrograph, the lattice match image of the rim side of single T-ZnO nanorod.

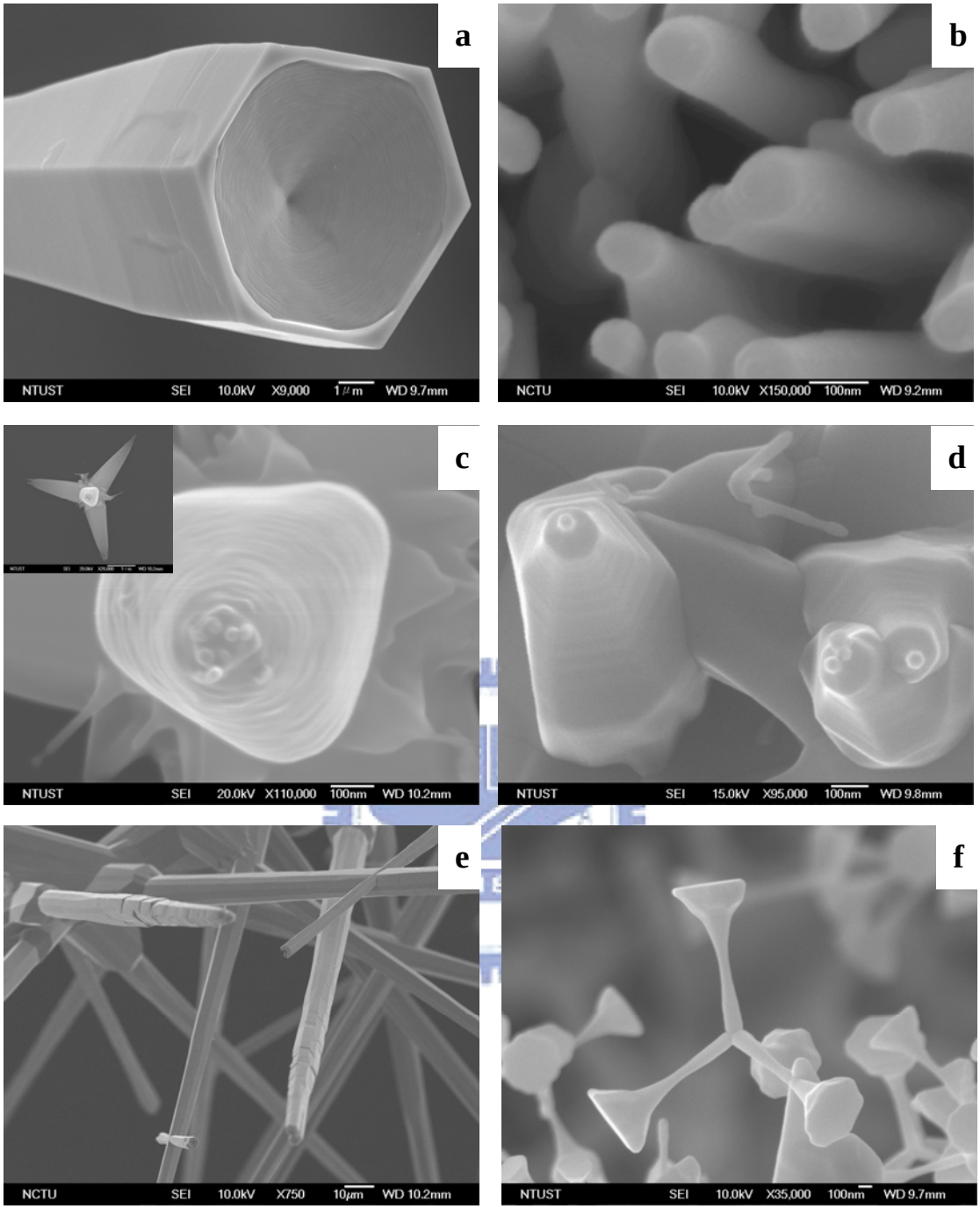

Figure 4.19 SEM micrographs of ZnO rods as the helical growth mechanism. **a**) Face-on view of the surface helical morphology of end-point of the individual ZnO rod. **b**) Top-view image of the ZnO rods as the helical growth. **c**) Single rod of tetrapods presented the helical growth process; inset in Figure4.19c is a condensed image of a freestanding ZnO tetrapods. **d**) Rods synthesized by helical like growth. **e**) Rods grown follow helical orientation toward one direction. **f**) End-point of the tetrapods with flow-like presented symmetrical growth.

Chapter 5 Conclusions

In summary, this research studied a catalyst-free and a method different to conventional horizontal tube furnace process for the preparation of large area of oriented ZnO nanosructures by harnessing the experimental conditions.

Several important results are summarized as follows:

1. ZnO crystals preferred to grow toward the basal plane in rich oxygen atmosphere.
2. Oxygen contained of ZnO structures influences not only the morphology but also the emission properties of ZnO tetrapods.
3. Growth of ZnO crystals followed helical-like model and layer-by-layer growth by VS mechanism in Zn-O vapor atmosphere.
4. Tetra-pod growth of ZnO crystals caused by lattice prefer [0001] orientation to form armor-unit-shape.

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