Polarity control of well-ordered epitaxial ZnO nanowire arrays by selective area growth

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A key advantage of ZnO is its ability to grow with the nanowire (NW) shape by low-cost and surface scalable deposition techniques such as chemical bath deposition (CBD). However, the control of the polarity of ZnO NWs in addition to the uniformity of their structural morphology in terms of position, vertical alignment, length, diameter, and period is still a technological and fundamental challenge for device integration.

In this work, ZnO NWs are grown by CBD on electron-beam pre-patterned polar c-plane ZnO single crystals. By combining CBD with selective area growth, we achieved the growth of both O- and Zn-polar ZnO NWs with a highly controlled structural morphology and a high optical quality. Notably, the polarity of ZnO NWs can be switched from O- to Zn-polar, depending on the polarity of the pre-patterned ZnO single crystals, as shown by convergent beam electron diffraction. Furthermore, the single O- and Zn-polar ZnO NWs additionally exhibit distinctive cathodoluminescence spectra. Based on these results, a new interpretation of the nucleation and growth mechanisms of ZnO NWs by CBD is deduced, helping to open the way to the ultimate fabrication of well-organized heterostructures made from ZnO NWs.