Morphology inducing maskless plasma etching of AlN nanocone arrays with tip-size dependent photoluminescence properties

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Bottom-up growth method has been a main way to form various AlN nanostructures but still existing many problems in uncontrollability and nonuniformity as well as low-throughput. Here we adopt firstly top-down maskless plasma etching method to fabricate easily a large-area AlN nanocone arrays on magnetron sputtered (002) AlN films, and unique pebble-like array morphologies of AlN films surface induce greatly the whole selective plasma etching process without any masked process (Figure 1). The as-formed AlN nanocones have not only kept the crystalline oriented (002) and microstructure of original AlN film, but also had a good uniformity and controllability in height and density as well as tip-size. These AlN nancone arrays exhibited an intense broad ultraviolet emission centered at 3.26 eV, and especially showing a tip-size dependent photoluminescence that were remarkably enhanced with decreasing the nanocone tip-size (Figure 2). Our results provide a promising route for controllable fabrication of AlN nanostructure and practical application of AlN-based various nanodevices in optoelectronics and vacuum-nanoelectronics.

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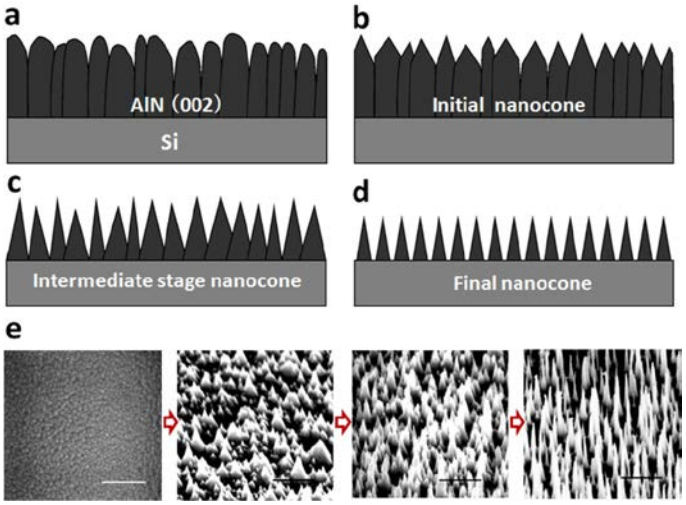

Figure 1: Illustration of morphological inducing maskless plasma etching AlN nanocone arrays. (a) (002) AlN film with surface morphology of pebble-like grains and columnar-like cross-section before plasma etching, (b) Etching initial stage, the top of columnar-like structure become the low conical shape due to pebble-like morphology inducing selecting etching, (c) and (d) After etching duration, the size and shape of nanocone is developed to form finally discrete and uniform nanocone arrays. (e) Real SEM morphologies of AlN film and nanocone arrays corresponding to each stage of plasma etching process from (a) to (d). Scale bar, 500nm

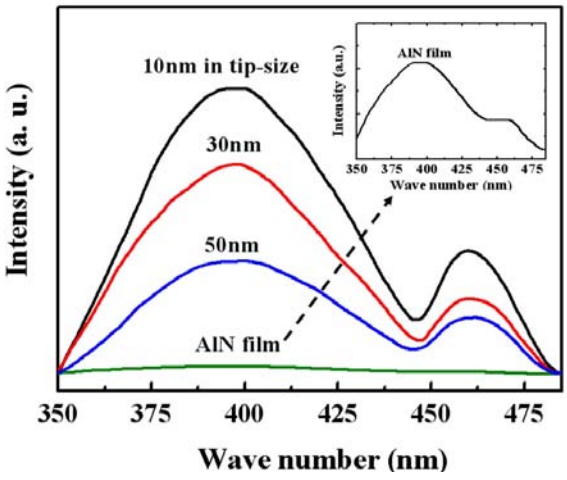

Figure 2 PL curves of AlN film and nanocone with various apex radiuses: 10nm, 30nm, 50nm, and AlN film with a inserted and enlarged PL spectrum.