FABRICATION OF DIAMOND CONE ARRAYS BY DIRECT BIAS-ASSISTED REACTIVE ION ETCHING

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A novel method of nanostructuring diamond films into cone arrays through bias assisted reactive ion etching (RIE) is reported. The method can be applied for both microcrystalline diamond, forming single-crystalline cones and for nanodiamond films, yielding nanodiamond cones. The density and the geometry of the cones are controlled by the initial texture of diamond films and the RIE conditions. Pyramidal [001]-textured films yield very sharp single-crystalline cones with the [001]-axis perpendicular to the substrate surface, an apical angle of approximately 28° and a tip radius as small as 2 nm (Fig. 1). Cones made of nanodiamonds with a similar apical angle of 28° and a variety of densities and sizes can be structured from nanodiamond films. A possible application is field electron emission (FEE), which is significantly improved in nanostructured cone arrays of all types of diamond films. The FEE of nanodiamond cone arrays is better than that of single-crystalline cone arrays of diamond with a similar density and geometry (Fig. 2).

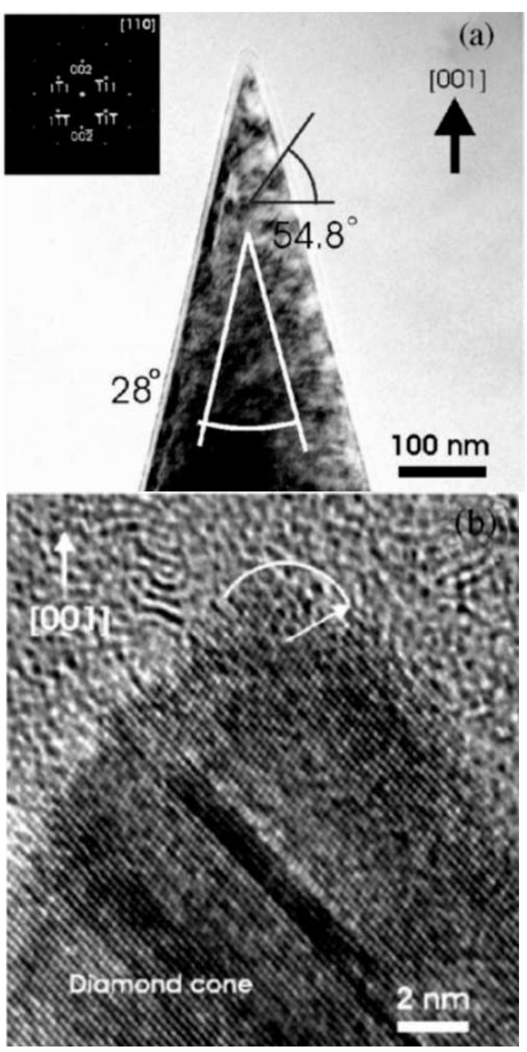

Fig. 1(a) Low-magnification TEM image of a single-diamond tip elucidating its sharpness and single-crystal nature. The corresponding TED pattern is inserted. The angle between crystal defects lying on the {111}-lattice planes and the substrate surface of 54.8° assists in determination of the tip direction ([001]). **(b)** High-resolution TEM image of a tip apical region. An apical radius of approximately 2 nm is demonstrated in the figure.

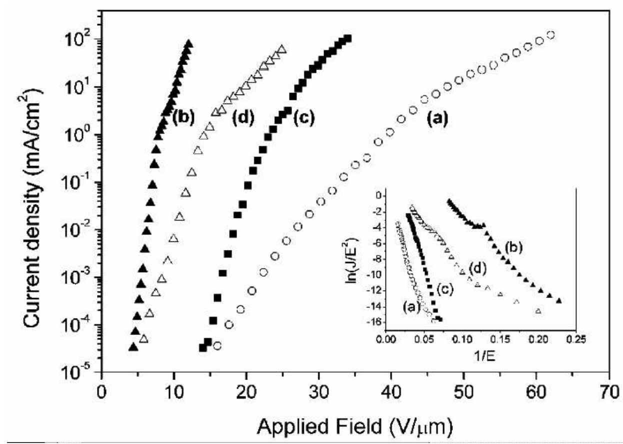

Fig. 2 The dependence of the emission current density on the applied field of the flat nanodiamond film **(a)**, low-density **(b)** and high density **(c)** nanodiamond cones, respectively. The dependence of low density single-crystalline-diamond-cone-array is shown in **(d)** for reference. The insert represents the corresponding Fowler–Nordheim plots of the current density–electric field data.