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Ultra sharp tungsten tips for field emission electron beam by using etching solution NaOH and KOH.

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A modification of common electrochemical etching present in two processes, Static and Dynamic. Our experimental setup is static method in which sodium hydroxide (NaOH) and potassium hydroxide (KOH) are used as electrolyte solutions in order to fabricate the needle electrode. We observed that the taper length, radius of curvature and roughness of surface varies with the applied voltage and concentration of solution. The drop-off process quickly occurs in NaOH solution than in KOH solution. The concentration of solution varies from 2N to 4N in 1 liter of DI water with immersed length 1000  $\mu\text{m}$  by using NaOH and KOH solution respectively. The diameter of tungsten wire (anode) is 150  $\mu\text{m}$ . After etching process, the shape of the tungsten tips is observed from Scanning Electron Microscope (SEM) and geometry of the tip can be analyzed in parabolic shape, hyperbolic shape and bullet like shape. The field emission point (FEP) in bullet like shape plays an important role for electron beam stability. The produced  $\text{H}_{2(g)}$  moves upward,  $\text{OH}^-$  ions move towards tungsten and  $\text{WO}_4^{2-}$  moves downward. The rate of etching is determined primarily by the applied voltage, immersion depth and concentration of NaOH/KOH.

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