Electron Emission From Ferroelectric Thin Film Cathodes

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The use of thin film ferroelectric materials as electron emission cathodes has been investigated. For commonly proposed applications of these materials, such as flat panel displays, electron emission currents higher than 10s of mA/cm^2 will be required. Strong pulsed electron emission from bulk ferroelectric cathodes has been widely reported (100s of A/cm^2), but some preliminary experiments on thin film ferroelectric cathodes showed that only relatively small currents (~0.1 $\mu A/cm^2$) are obtainable when the thickness is reduced to a few microns. Because of the attractive advantages of thin film cathodes in flexibility and low switching voltage, we are studying ways to improve the emission performance. Four kinds of ferroelectric thin films have been made by the sol-gel method. They are $Pb_{0.93}La_{0.07}(Zr_{0.53}Ti_{0.47})O_3$ (PLZT), $Pb_{0.98}La_{0.02}(Zr_{0.95}Ti_{0.05})O_3$ (PLZT), $Pb(Zr_{0.65}Ti_{0.35})\ O_3$ (PZT), and $Pb(Zr_{0.53}Ti_{0.47})O_3$ (PZT), and each has a thickness of approximately 1 μm. Each of these stoichiometries is commonly used so our results will be comparable to previous reports. The films were grown on 0.5 μm Pt layers deposited on Si wafers; the Pt serves as the rear electrode. Using standard photolithography techniques, the cathode top electrodes (also 0.5 μm Pt layers) were patterned into strips that have equal width and spacing between strips. For comparison, three patterns of different electrode strip width, 1.5 μm, 3.0 μm, and 10 μm were selected. It has been suggested in the literature that the top electrode pattern width should match the thickness of the film for high emission efficiency. The electrode strip widths used here are much smaller than those reported by others (200~300 μm) and are expected to have better emission performance. The measured emission current as a function of switching voltage, rise time, and repetition rate; extraction voltage; material stoichiometry; and top electrode pattern dimension will be presented.

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