Cold Cathodes of Low Electron Affinity and Negative Electron Affinity thin films and nanoclusters

M. Cahay[a] S.B.Fairchild[b], P.T.Murray[c], T.C.Back[d], V. T. Binh[e], and D. J. Lockwood[f]

[a] *Department of Electrical and Computer Engineering, University of Cincinnati, Cincinnati, OH 45221-0030, marc.cahay@uc.edu*

[b] *Air Force Research Laboratory, Materials and Manufacturing Directorate, AFRL/RXPS, Wright-Patterson AFB, OH 45433*

[c] *Research Institute, University of Dayton, Dayton, OH 45469-0170*

[d] *Universal Technology Corporation, 1270 N. Fairfield Rd, Dayton, OH 45432*

[e] *Equipe Emission Electronique, LMPMC-CNRS, University of Lyon 1, Villeurbanne 69622, France*

[f] *Institute for Microstructural Sciences, National Research Council, Ottawa, Ontario K1A OR6, Canada*

Rare-earth monosulfides having the rocksalt structure offer a more stable alternative than alkali metals to reach low or negative electron affinity (LEA,NEA) when deposited on various III-V and II-VI semiconductor surfaces[1-3]. Two other important features of the rocksalt form of these rare-earth monosulfides are their relatively high melting temperature (> 2000 ^{o}C) and their fairly low electrical resistivity (a few tens of μΩ-cm). For the last ten years, we have developed a new class of field emitters based on rare-earth monosulfide thin films. We have successfully deposited Lanthanum Monosulfide (LaS) via Pulsed Laser Deposition on Si[4-5] and MgO[6] substrates and on alumina templates[7]. The field emission properties of these films have been characterized by Scanning Anode Field Emission Microscopy (SAFEM)[8]. Recently, we have developed a patchwork field emission model[7-9] to explain the effective low surface barrier (~ 1eV) of these field emission cold cathodes measured using the SAFEM technique. In this patchwork model, nanocrystals of low work function materials on the surface of the films are surrounded by a matrix of amorphous materials or nanocrystals with higher work function. The latter prevent absorption of molecules onto the lower work function nanoareas protecting them from contamination until a bias applied to an anode in close proximity opens up channels for efficient field emission on top of the 1eV nanocrystals. This is the main reason for the reliability of these cathodes. More recently, we have been successful in synthesizing nanoclusters of LaS using a Pulse Laser Ablation process[10]. We will explain how rare-earth monosulfides can be used to make highly efficient, durable, and realiable LEA and NEA cold cathodes. So far, LaS was used successfully as a cathode emitter in halogen

lamps, in cold cathodes with measured emitted current densities as high as 50 A/cm^2 , and as efficient cathode electrodes in organic light emitting diodes.

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