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Detailed analyses of photoluminescence spectra of InAs quantum dot in GaAs sandwich

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InAs quantum dots grown by migration-enhanced molecular beam epitaxy have been investigated. The power dependence and temperature dependence are also reported. The activation energies E_{a1} and E_{a2} are found at the range from 313 to 316 meV and form 48 to 58 meV respectively. The theoretical value of InGaAs band gap is from 0.35 eV at room temperature to 0.415 eV at 0K, but observed value of photoluminescence peak energy is 1.1 eV. In this paper we explained that there is no contradiction between these two values. The photoluminescence peak position we found is red-shifted with increasing temperature. The power dependence measured from 0.1 mW to 35 mW, the radiation from first excited state start to appear at relatively high power.

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Energy Exchange and Cooling of Field Emission from Semiconductors

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The energy exchange in field emission from semiconductors is theoretically investigated. As for the cathode, the outgoing and incoming electrons are equal in numbers but different in energy. Thus field emission gives rise to cooling or heating. The energy exchange is obtained as difference between the average energies of field and replacement electrons. If the energy exchange is positive, the cathode loses heat via field emission of electron and is cooled. Analytic and numerical calculations are made to describe the replacement process of the injected charge carriers to compensate the field emission. It leads to analytic expressions for the energy exchange, which exhibit the dependence on field, temperature, and doping concentration in a parametric form. The results reveal the important feature that the energy exchange is positive for all temperatures. This implies that field emission always give rise to cooling for a semiconductor emitter. This feature is not found in a metallic emitter where field emission produces heating and cooling depending on temperature. When Joule heating is included, there is still a net cooling for a wide range of emitted current density. More detail discussions will be presented at the conference.