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Bias activated dielectric response of excitons and excitonic Mott transition in quantum confined lasers structures. KANIKA BANSAL, AMIT BHUNIA, SHOUVIK DATTA, Department of Physics, IISER, Pune 411008, Maharashtra, India, MARZOOK S ALSHAMMARI, National Center of Nanotechnology, KACST, Riyadh 11442, Saudi Arabia, MOHAMED HENINI, School of Physics and Astronomy, University of Nottingham, Nottingham NG7 2RD, UK —
In contrast to the widely reported optical techniques, there are hardly any investigations on corresponding electrical signatures of condensed matter physics of excitonic phenomena. We studied small signal steady state capacitance response in III-V materials based multi quantum well (AlGaInP) and MBE grown quantum dot (InGaAs) laser diodes to identify signatures of excitonic presence. Conductance activation by forward bias was probed using frequency dependent differential capacitance response (fdC/df), which changes characteristically with the onset of light emission indicating the occurrence of negative activation energy. Our analysis shows that it is connected with a steady state population of exciton like bound states. Calculated average energy of this bound state matches well with the binding energy of weakly confined excitons in this type of structures. Further increase in charge injection decreases the differential capacitive response in AlGaInP based diodes, indicating a gradual Mott transition of excitonic states into electron hole plasma. This electrical description of excitonic Mott transition is fully supplemented by standard optical spectroscopic signatures of band gap renormalization and phase space filling effects.

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