# Room temperature THz intersubband transitions in continuously-graded $Al_xGa_{1-x}As$ parabolic quantum well arrays

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While conventional THz optoelectronic devices operate in the weak coupling regime between light and matter, the strong coupling regime provides an attractive alternative. For such devices, parabolic quantum wells (PQWs) will be critical in enabling operation up to room temperature. Unlike the more ubiquitous square wells, PQWs have equal intersubband (ISB) spacing, which provides a strong, unified absorption line independent of thermal occupation.

PQWs in $Al_xGa_{1-x}As$ can be grown with molecular beam epitaxy (MBE) using digital alloys, however this technique only approximates the parabolic potential, and it also generates many interfaces. We instead generate a smooth composition gradient, employing a linear dynamical model of our Al cell to smoothly vary the flux at standard growth rates [1].

Using this technique, we grow a stack of 54 PQWs with Al varying between 2-30%. We demonstrate the quality of this sample using multipass transmission spectroscopy. The measured transmittance in Figure 1 demonstrates a clear THz ISB absorption at both 300K and 8K with minimal shift of the peak. The temperature dependence of the linewidth is particularly noteworthy – below 100K, the linewidth is exceptionally small, reaching a record-low value of 5.7% of the center frequency.

Further work will aim at incorporating these PQW arrays into THz devices operating in the strong coupling regime at around 100K, obtaining performance levels presently only achievable at liquid helium temperature.

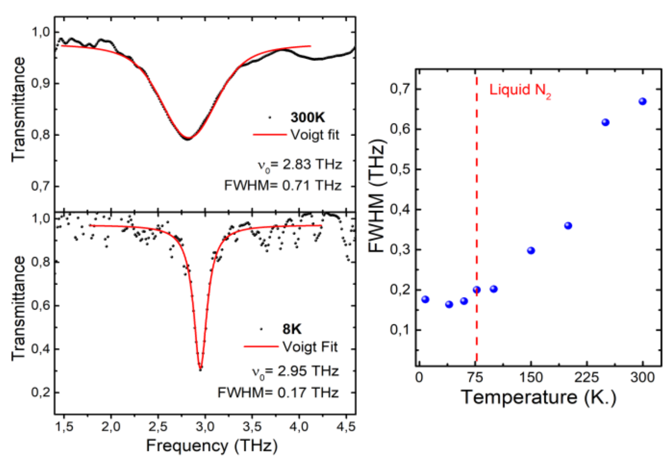


**Figure 1**: Transmittance measurement of the PQW sample at 300K (upper left) and 8K (lower left). Full-width at half maximum of the absorption as a function of the temperature (right panel).

[1] C. Deimert, Z. R. Wasilewski, *Journal of Crystal Growth* **514**, 103-108 (2019).

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