Electronic Supplementary Information for

Controlling the Random Lasing Action from GaAs/AlGaAs Axial Heterostructure Nanowires Array

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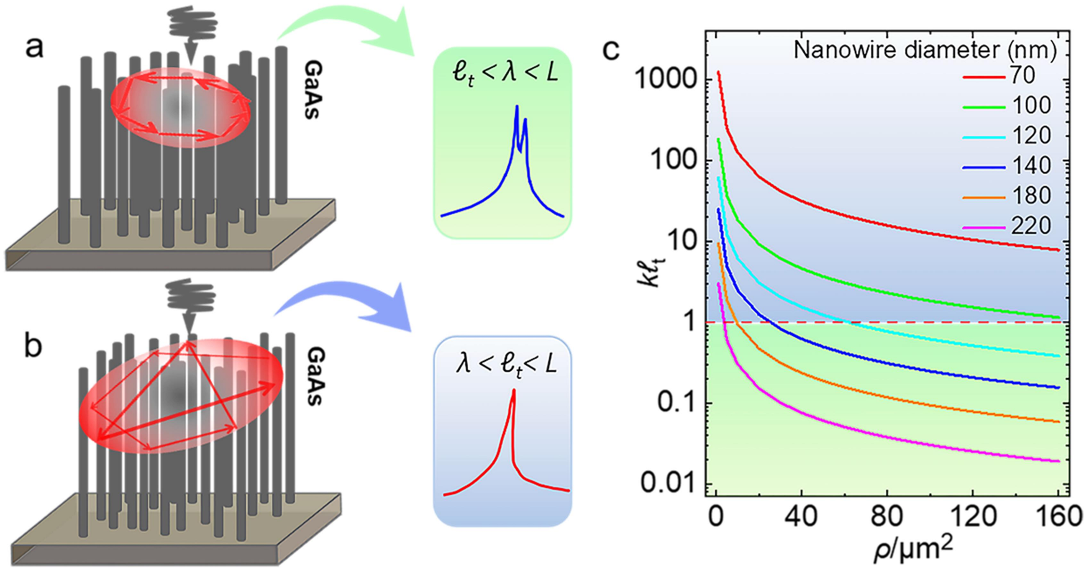

Figure S1. Design of random laser based on GaAs NWs array. (a) and (b) demonstrate vertical NWs arrays for Anderson localized and delocalized regimes, respectively. The NWs are irradiated by a pulse laser with intensity $I(\lambda)$ from the top. The insets depict their schematic lasing spectrum. (c) The relationship between the density and average GaAs NWs diameter with $k\ell_t$.

Figures S1a and S1b present schematic diagram of the vertically aligned GaAs NWs array. The NWs have a total length of 4 μm. The insets of Figure S1a and S1b schematically show the lasing spectrum and requirement for the Anderson localized and delocalized random lasers. Generally, narrow lasing peaks can be observed over a broad background for Anderson localization, while delocalization typically results in broad lasing emission. The correlation between density, average diameter of GaAs NWs, and ℓ_t was examined to regulate the random lasing regime based on ℓ_t, as shown in Figure S1c. The red dash line indicates[1] $k\ell_t \simeq 1$ (where the wavenumber $k = 2\pi/\lambda$). The green area below the dash line implies the Anderson localized regime, while the area above the dash line belongs to the delocalized regime. Based on the data presented in Figure S1c, it can be seen that GaAs NWs arrays with average diameters of 120, 140, 180 and 220 nm satisfy the Anderson localization regime when their densities are at least 60.88, 25.39, 9.80 and 3.79/μm^2, respectively.

For arrays consisting of NWs with average diameters of 70 and 100 nm, the delocalization mechanism will be satisfied when their densities are in the range of 1-160/μm^2. In terms of scattering alone, pure GaAs NW arrays require higher thresholds and greater densities to realize Anderson localization and delocalization random laser modulation. This is due to the fact that the ℓ_t in GaAs NWs arrays of the same density is greater than that in GaAs/AlGaAs axial heterostructure NWs arrays[2].

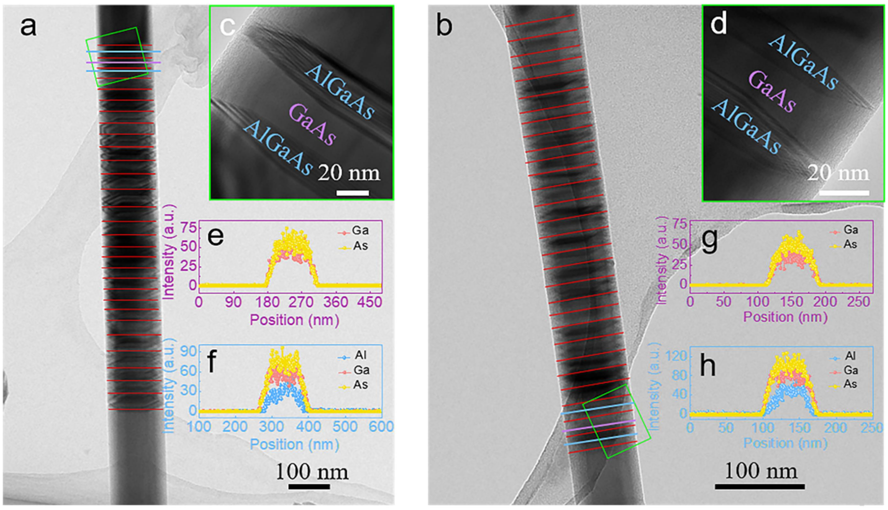

Figure S2. GaAs/AlGaAs NW heterostructures. (a) and (c) show the cross section TEM and HRTEM images of the NW for Anderson localized region. (b) and (d) show the cross section TEM and HRTEM images of the NW for delocalized region. Figures (e), (f), (g) and (h) show the element distribution of GaAs and AlGaAs in two kinds of NWs, respectively.

References

1 H. Cao, *J. Phys. A: Math. Gen.*, 2005, **38**, 10497–10535.

2 J. Yi, G. Feng, L. Yang, K. Yao, C. Yang, Y. Song and S. Zhou, *Opt. Commun.*, 2012, **285**, 5276–5282.