Highly Tensile-Strained Self-Assembled Ge Quantum Dots on InP Substrates for Integrated Light Sources

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S1 TEM of the large-size Ge QDs sample

For the sample with large Ge QDs (S1), defects from the surface of Ge QDs to the InGaAs capping layer are observed as shown in the bottom left figure of Figure S1. But the region without Ge QDs are defect-free as shown in the bottom right figure of Figure S1. The angle between the defect and Ge/III-V interface is 55° or 125°. The possible reason for the formation of the defects is the polar on non-polar nature of $In_{0.52}Al_{0.48}As$/Ge interface. Controlling the sizes of QDs or annealing may reduce the density of the defects.

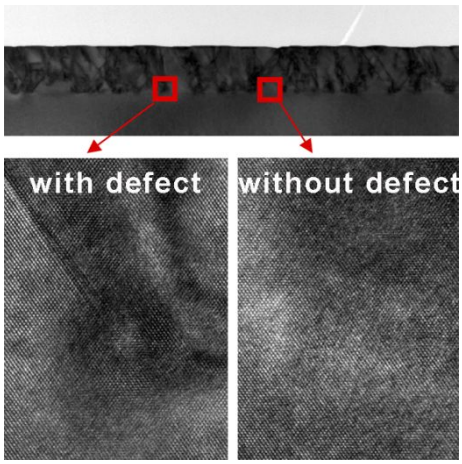

Figure S 1 HR-TEM images of S1, showing the region with defect (left) and without defect (right).

S2 Band structure of Ge QDs/InAlAs

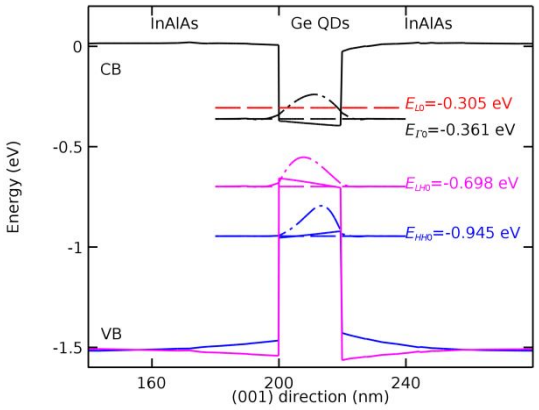

Figure S 2 Band edges of Ge QDs/InAlAs emitting structure along (001) direction. The dash lines represent the energy of ground states of electrons and holes. The dash dot lines represent the corresponding effective-mass wavefunctions.

Table S1. Parameters of Ge and InAlAs

Parameters	Ge	AlAs	InAs	$Al_{0.48}In_{0.52}As$
a_0 (Å)	5.6533	5.6610	6.0583	5.8676
Effective masses				
m_c (m0)	0.041	0.15	0.026	0.073
$m_{t,L}$ (m0)	0.082	0.15	0.05	0.098
$m_{l,L}$ (m0)	1.59	1.32	0.64	0.97
Luttinger's parameters				
γ_1	13.35	3.76	20	12.20
γ_2	4.25	0.82	8.5	4.81
γ_3	5.69	1.42	9.2	5.47
Bandgaps				
E_{va} (eV)	-6.35	-7.49	-6.67	-7.06
$E_{g,\Gamma}$ (eV)	0.89	3.13	0.41	1.54
$E_{g,L}$ (eV)	0.74	2.46	1.133	1.77
Δ (eV)	0.3	0.28	0.39	0.30
Deformation potentials				
a_c (eV)	-8.24	-5.64	-6.08	-5.52
a_L (eV)	-1.54	-	-	-
Ξ_u (eV)	16.3	-	-	-
Ξ_d (eV)	-6.97	-	-	-
a_v (eV)	1.24	2.47	1	1.71
b (eV)	-2.9	-2.3	-1.8	-2.04
Elastic constants				
C_{11} (GPa)	131.5	125	83.3	103.3
C_{12} (GPa)	49.4	53.4	45.3	49.2
C_{44} (GPa)	68.4	54.2	39.6	46.6