S1 Pillar shape as function of Etch time:

Multilayer samples with a suitable colloidal mask layer were etched by ICP-RIE for different time durations (3, 4, 5 min) with other etch parameters same to modify pillar shapes and sizes (Figure S1). By etching for longer times, the pillars become conical due to rapid erosion of silica mask particle in the later stage of etching. It is possible to etch only few layers choosing short etching time to get lower density of disks. Optimum etch time to get circular disks while exposing all the layers in the grown structure is 4 min (Figure S1 (b)). Thus, it is possible to obtained desired nanodisk diameters either by changing the NP etch conditions or the original colloidal silica mask particle diameters.

Figure S1: Cross-sectional SEM views of InGaAsP/InP multilayer pillar arrays etched for different time durations: (a) 2.5, (b) 4, and (c) 5 minutes.
Uniform diameter reduction of InGaAsP/InP multi-layer NPs:

It is possible to obtain smaller disk diameters, by subjecting the as-fabricated multi-layer NP arrays to controlled sculpting in a sulfur-oleylamine solution. This process is applied for different durations to obtain the desired diameters, as shown in Figure S2. This treatment is applied on both InGaAsP/InP to reshape tapered pillars into facetted wires with fairly uniform diameters. Combining these processes with selective wet etching, high optical quality quantum confined quasi-3D particles can be obtained.

Figure S2: InGaAsP/InP pillars (a) as etched and after non-selective wet chemical treatment for (b) 90 min chemical treated (c) 155 min. The remaining silica particles are also visible and provide a visual measure for the reduction in NP diameter.

Nanodisk density control:

Nanodisk density, i.e. the areal coverage of the stamped discs on Si, can be controlled either by exposing fewer layers while etching or during the stamping process. During stamping process the same PDMS stamp could be used many times to get areas with very high to very low densities. Figure S3 shows areas with three different densities of the stamped nanodisks obtained by using the same PDMS stamp.
Figure S3: SEM micrographs showing InP nanodisks with uniform diameter and thickness stamped on Si with different densities.

S4 InGaAsP disks from conical pillars:

Stamping of even very small size particles is possible using PDMS. Very small disks obtained from conical pillars with diameters less than 100 nm were stamped as shown in Figure S4-1 and S4-2. In this case, the particle shapes are also different, some being circular, and some others, conical. PL measurements show quantum confinement effect for these disks stamped on Si. Areas containing smaller size disks show energy shift of about 20 meV (Figure S4-3), compared to bulk material. Whereas areas with large disks (both in diameter and thickness), as expected show PL comparable to bulk material. At other regions with more number of smaller size disks compared to larger ones PL is composed of emission from both types of disks, displaying double-peak (shoulder) spectra.
**Figure S4-1:** SEM top views of nanodisks obtained from conical InGaAsP/InP pillars stamped on Si.

**Figure S4-2:** SEM top views of nanodisks, stamped on Si, with conical shape and small diameters obtained from conical NPs.

**Figure S4-3:** PL spectra of GaInAsP nanodisks, stamped on Si, obtained from conical NP pillar arrays. The spectra were measured at different areas (spots) containing different disk sizes.
InP/InGaAs structure:

Multi-layer NP arrays were also fabricated in InGaAs/InP stacks, and used to generate InP as well as InGaAs disks (Figure S5-1). The structure has 100 nm InP and 20 nm InGaAs, alternatively, with total of five InGaAs layers. Both InP and InGaAs disks successfully transferred to Si substrate. InP nanodisks show very good PL. However, InGaAs disks do not show room temperature PL, due to high surface state densities, typical for these materials.

Figure S5-1: InGaAs/InP pillars (a) as etched (b) InGaAs disks transferred on Si using PDMS stamp and (c) all five InGaAs disk layers on Si obtained from single pillar.

As for the GaInAsP/InP case, here also S-OA treatment is effective to produce InGaAs/InP multi-layer nanopillars with uniform and reduced diameters (Figure S5-2).
**Figure S5-2:** InGaAs/InP pillars after non-selective wet chemical treatment for 90 min. The material contrast is also visible, delineating the InGaAs and InP layers. Also note the faceted side-walls as a result of anisotropic etching by S-OA solution.

**S6 Effect of layer sequence on photoluminescence of InGaAsP/InP NPs:**

As discussed in the main article the PL spectra obtained from multilayer pillars shows a blue shift compared to stamped (bulk) InGaAsP nanodisks. This blue shift is attributed to thermalization of carriers to 20 nm InGaAsP QWs. To investigate this nanopillar arrays were fabricated from two different structures (I and II, shown in Fig. S6-a1 and S6-a2 respectively). In case of structure II (Fig. S6-a2), the PL will have significant contribution from 20 nm InGaAsP QWs in the upper parts and will be blue shifted compared to structure I (Fig. S6-a1). Indeed, as seen on Fig. S6(b) and (c), the PL spectra of NPs with structure II are consistently blue-shifted compared to NPs with structure I. As expected, at RT due to redistribution of carriers in the nanopillars, the PL spectra (Fig. S6(b)) are broader for both the structures. The shoulders are also visible, indicated by arrows in Fig. S6 (b). However at 77K, line widths are narrow and comparable (Fig. S6(c))
Figure S6: (a) Presents two different InGaAsP/InP structures; insets show fabricated nanopillar arrays from corresponding structure. (b) and (c) show spectra of InGaAsP/InP multilayer pillars in structure I and II at RT and 77K respectively.