

## Supporting Information

### Synthesis and morphology evolution of Indium nitride (InN) nanotubes and nanobelts by chemical vapor deposition

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In Fig.S1, SEM images are taken from the center of samples, the morphology of samples is the  
same for samples at the edge or center. The difference lies in the density and the length of samples.  
The density and the length of some InN nanostructures samples in the edge are lower and longer.  
As can be seen from the Fig.S1. At a(700°C), the morphology of samples in the edge is InN NWs.  
The density and the length of samples in the edge are lower and longer. At b(715°C), the  
morphology of samples in the edge is InN NBs with triangular edge. The density and the length of  
samples in the edge are lower and longer. At c(725°C), the morphology of samples in the edge is

InN NBs rolls and grows wider and longer. The amplitude of the InN NBs curls is much larger. The density and the length of samples in the edge are lower and longer. At d(735°C), the morphology of samples in the edge is hollow InN NTs. The density of samples in the edge is lower.

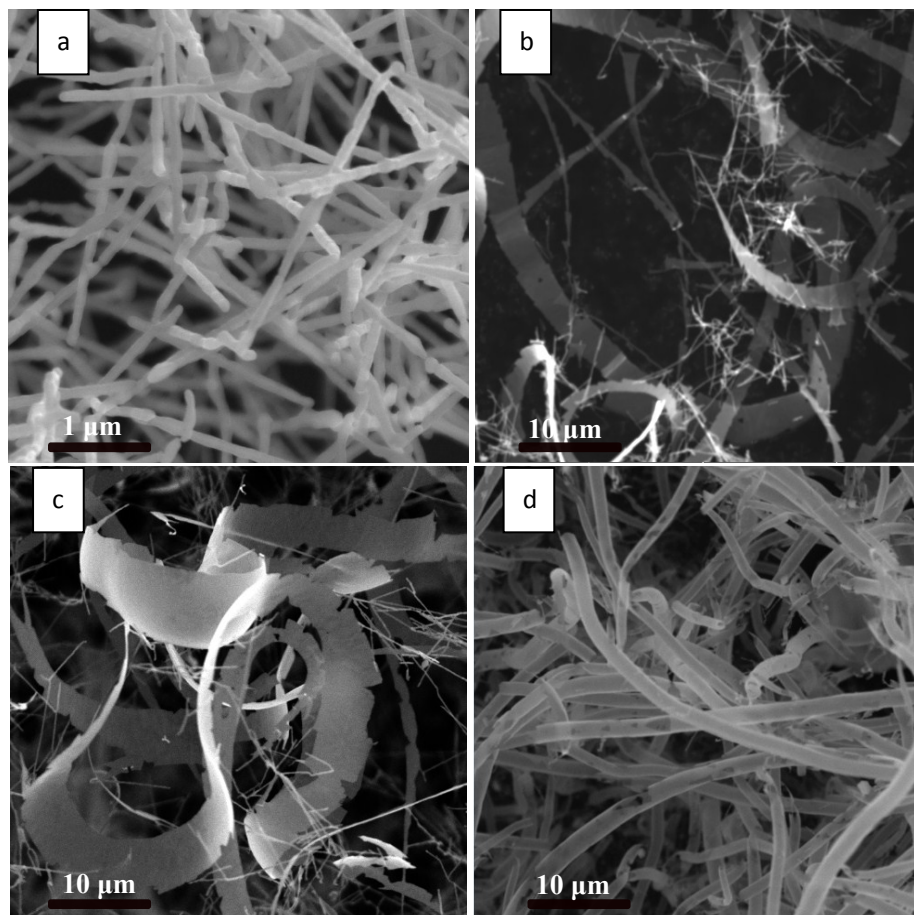


Fig.S1, SEM images were taken from the edge of samples, respectively.

As can be seen from the Fig.S2, the tube furnace exhibits Arc shape. The quartz boat we used is also Arc shape. The indium powder disperses in the quartz boat. The silicon (100) substrate coated with a 4 nm gold particle is placed face down on the quartz boat. Obviously, the same temperature in the cross section of the position between the center and edge of the silicon (100) substrate should be the same. However, the amount of indium powder in the center of the quartz boat is slightly more than the edge of the boat. The growth temperature governs the indium powder evaporation. While Indium molecular concentration in the center of the quartz boat is higher than the edge. The interspace is supersaturated with InN vapor, followed by nucleation and growth of InN crystals. This leads to the samples growing much faster in the center. So the InN morphology difference at the center and edge of the quartz boat, is not due to the distance between the center

and edge of the substrate that governs the InN nanostructure morphology. The distribution of InN nanostructures is not homogeneous within the interface but different from region to region, indicating that the degree of supersaturation is not the same throughout the interspace. [1] At the same temperature, the growth of InN crystals with various morphologies from vapor phase is explained by the vapor-solid (VS) growth mechanism where the degree of supersaturation determines the prevailing growth morphology in different region. [1] There's a critical temperature in the InN crystals variation. This is also can explain the Fig.S1 formation in our report. In addition, we also find the formed Indium ball particles in the center of the quartz boat are much larger than the edge. It's proved that the degree of Indium supersaturation in the center is higher than the edge.

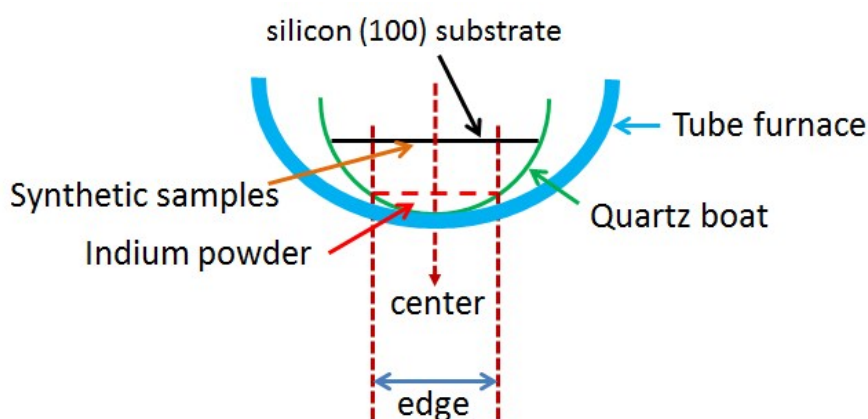


Fig. S2. Cross section diagram of synthetic samples in the tube furnace, respectively.

The morphological changes under different heating temperatures are equivalent to adjusting the temperature of the raw material to achieve the purpose of its concentration change, thus affecting the difference in the diffusion rate of surface molecules. SEM and TEM across large region at different temperatures of InN crystals are carried out to prove this. As we know, different rough surface of InN NWs has been synthesized with Au nanoparticles as the catalyst. [4] In the process of forming a rough surface of indium nitride nanowire, the InN molecules will transfer through the droplet thoroughly and effectively for nucleation and growth at the liquid-solid interface. It can be seen this situation of InN particles on the sidewall of InN NWs in S3 (a). However, the melting degree of the alloy droplet related to the size effect, varying compositions of the droplet and VS-assistant growth combined with different polarities of side planes. [4] The ability to capture evaporated indium molecules and cracked nitrogen molecules in the process of

forming rough surface on InN nanowires is randomness. This can explain sporadic nanoparticles exist on some nanowires. Then the formation of new nanowires proceeded by the VLS mechanism, followed by the removal of droplets by evaporation and continued growth by the VS mechanism. [1] In addition, a flat 2D nanostructure is forming in the connection between existed rough nanowire and new nanowire. The angle in S3 (a) forms a circular shape in S3 (b). It is similar to the morphological evolution of the triangle h-BN. [5] It shows that the growth process changes from a kinetically limited process to diffusion control mode. [6] But the diffusion capacity of InN molecules is weaker than growth dynamics at low temperature (700 or 705 °C). As the temperature increase to 710 or 715 °C, the diffusion capacity of InN molecules is stronger than the initial stage. Low-magnification TEM image of the InN jagged strip in S4 indicates this feature. At the end of the jagged strip, a smaller number of triangles are formed. In the middle of the jagged strip, a number of triangles and polygons are formed. At the top of the jagged strip, the number of triangles and polygons are decreased. The formed triangles and polygons are also found in WS<sub>2</sub>, [7] MoS<sub>2</sub> [8] [9] and h-BN.[5] The difference in the concentration of its raw material molecules on the surface of copper causes different diffusion rates, which in turn causes h-BN to exhibit different morphological evolution processes. [10] [11] This morphology change indicates the heating temperature of the precursor can effectively regulate the concentration of the precursor molecule, which increases the diffusion rate. So in the same InN jagged strip, the diffusion rate of its top is faster than the middle, which is faster than the end. Furthermore, When the temperature is increased to 720 or 725 °C, we can find a number of polygons and little triangles on the surface of large nanosheet in S5 (a) and (b). This indicates the InN diffusion rate is faster than the jagged strip as discussed before. Moreover, S5 (c) shows the angle of Triangle flattened in the nanobelt. This can be explained by the acknowledged Mullins-Sekerka instability. In general, when the external atoms spread to the edge of the material, it first chooses to adsorb at the vertices of the edges (ie, the vertices of the triangles) so that the growth concentration of the vertices is greater than that of the surrounding edges. As a result, the growth rate of the former is greater than that of the latter, and eventually the structure of the concave edges is formed with the evolution of the growth time. [12] The decreased number of polygons around flattened angle also shows this feature. As mentioned earlier, at a more elevated temperature (730 or 735 °C), S5 (d) shows few or none polygons on the surface of hollow InN nanotubes. This indicates the InN diffusion rate is

faster than nanobelt. However, because of the formation mechanism of InN jagged strip evolved into hollow nanotubes, the unclosed triangles are formed later. There are still triangles on the surface of the nanotubes. The above discussion is based on the same InN jagged strip evolved into nanotubes and nanobelts.

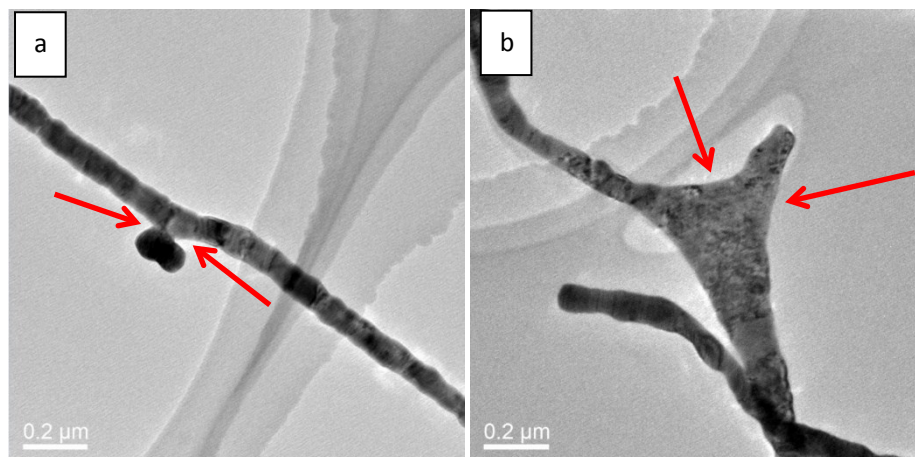


Fig.S3 the growth process changes from a kinetically limited process to diffusion control mode (a) Low-magnification TEM image of InN particle on the sidewall of InN NW (b) a flat 2D nanostructure is forming in the connection between existed rough nanowire and new nanowire.

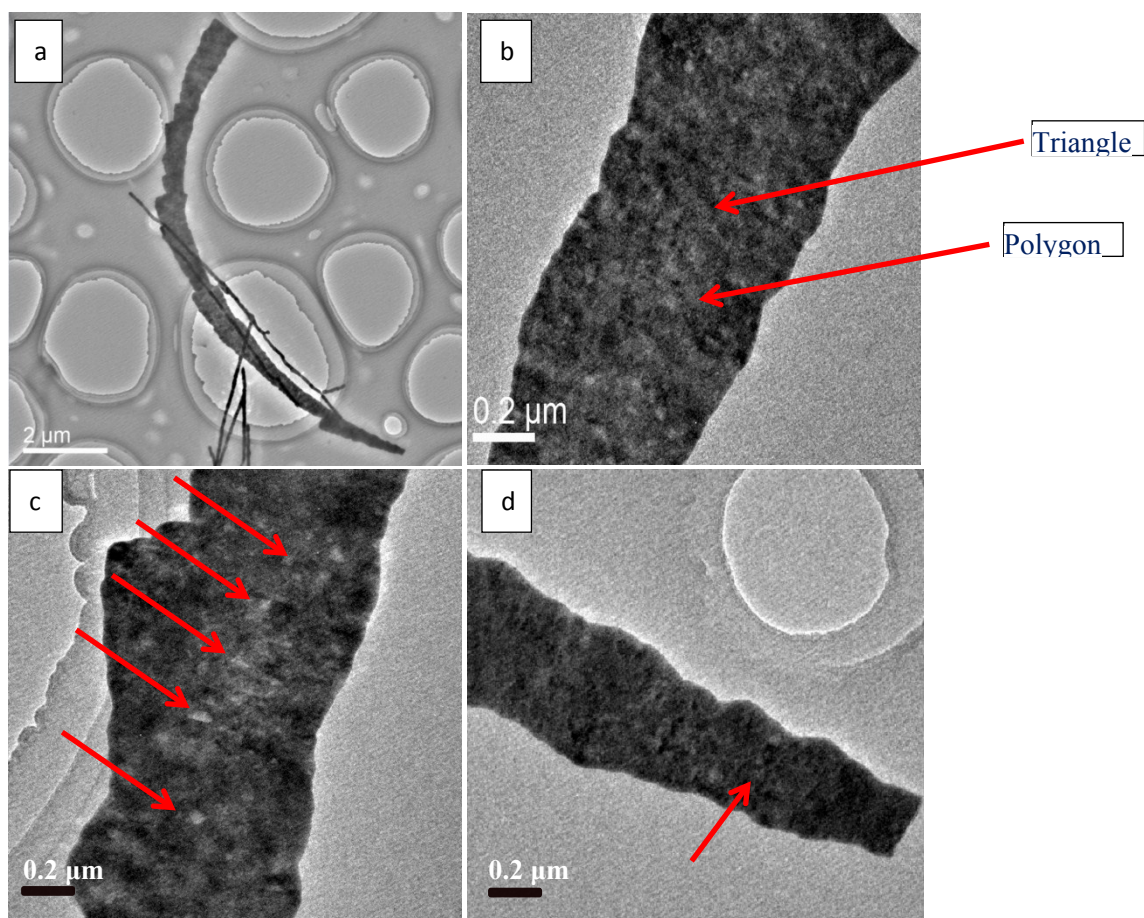


Fig.S4 the diffusion capacity of InN molecules (a) Low-magnification TEM image of the InN



jagged strip (b) the number of triangles and polygons decreased on the top part (c) a number of triangles and polygons formed in the middle part (d) the end part with a smaller number of triangles

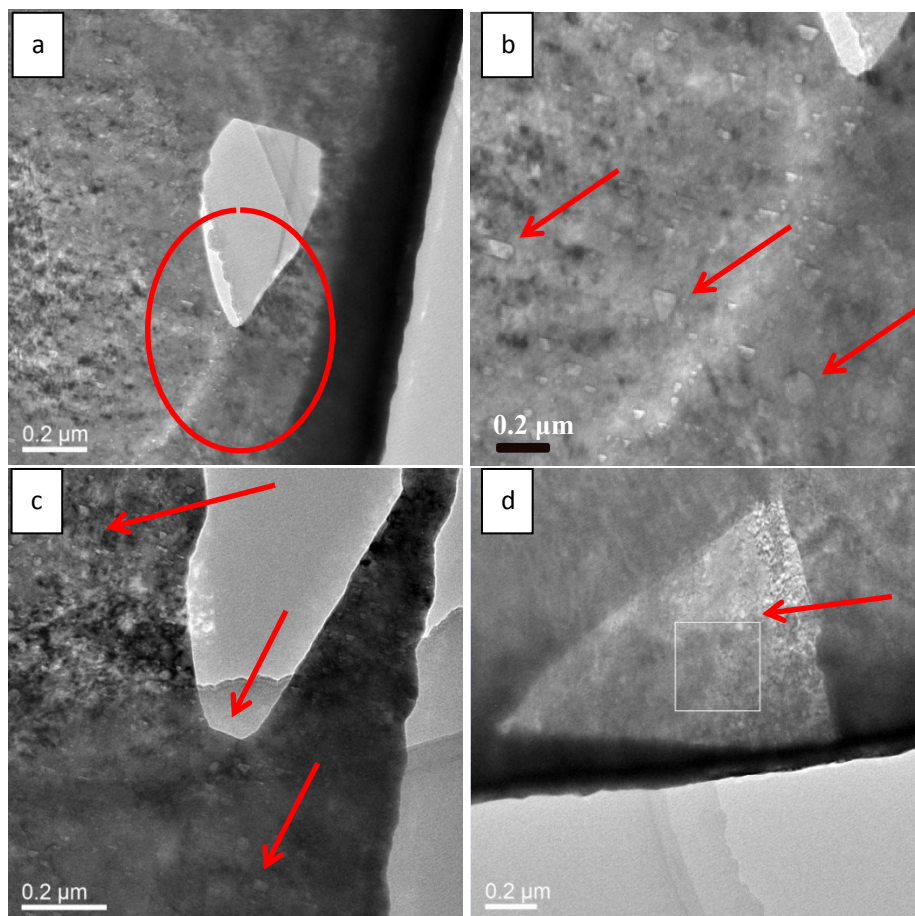


Fig.S5 the diffusion rate increased with morphology variation at different temperatures

(a) Low-magnification TEM image of InN nanosheet (b) a number of polygons and a little triangles on the surface of large nanosheet (c) the nanobelt with decreased number of polygons around flattened angle (d) few or none polygons on the surface of hollow InN nanotubes with unclosed triangles.

To confirm that the material really passes all these stages and the InN NBs and NTs nanostructures is not formed independently directly from the Indium powder at the different temperatures. We take InN narrow triangular sheets grown at 710 °C and heated them to 720 and 735 °C. The SEM images Fig.S6 we obtained are similar to the ones displayed here for InN synthesized directly from Indium and ammonia at 720 and 735 °C. The density of InN NBs and NTs nanostructures are more pure. There is no other morphology are found in this situation. The morphology evolution of InN NBs and NTs are proved to be actually.

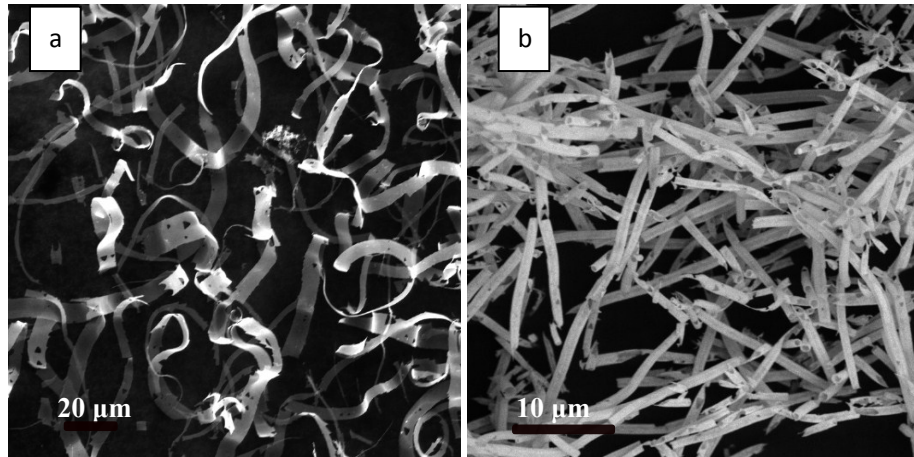


Fig.S6 the products of InN narrow triangular sheets grown at 710°C and heated them to 720 and 735°C, InN (a) NBs and (b) NTs

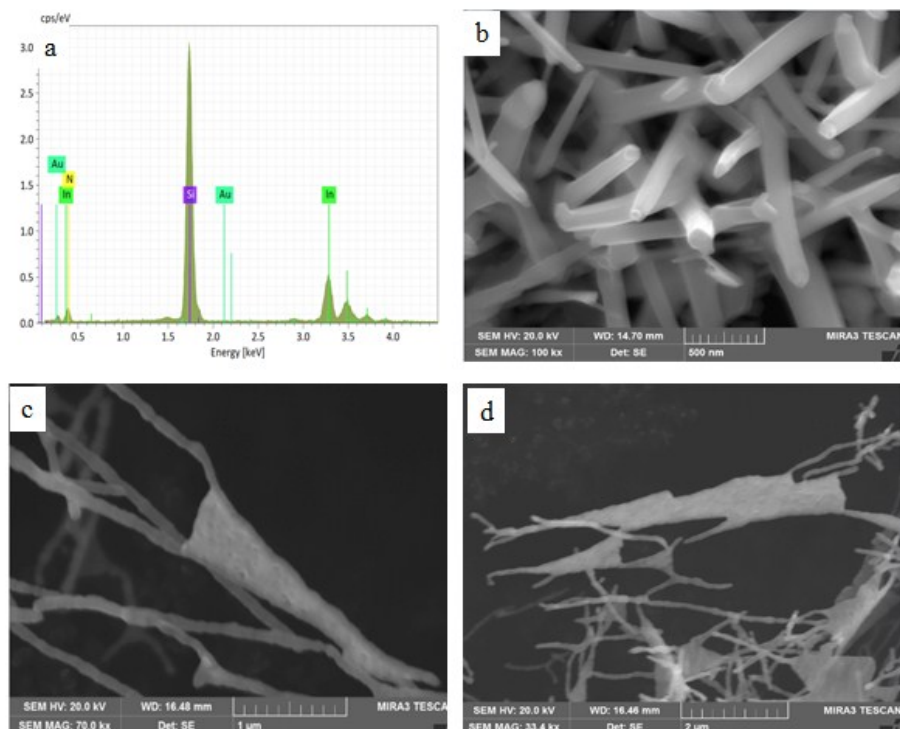
In conclusion, by adjusting the temperature of the indium material enables to adjust its concentration, thus manipulating the surface molecular diffusion speed, the morphology can be such large different with slightly changing the growth temperature.

Fig.S7 a EDS spectrum of InN nanostructure

Fig.S7 b catalyst particles or metal droplets on the top of InN NWs

Fig.S7 c fusion of nanowire to leaf membrane from surface diffusion

Fig.S7 d angle formation of two or more jagged strips connect each other



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