Supporting Information

Polarization-Selecting III-Nitride Elliptical Nanorod Light-Emitting Diodes Fabricated With Nanospherical-Lens Lithography

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SI-1. Fabrication of Ni nano-ellipse arrays using Nanospherical-Lens Lithography (NLL)

Arrays of elliptical nano-ellipses can be fabricated using NLL with a regular fluorescent lamp as the UV light source. The previous demonstrated nano-ellipses were very large and the nominal length of the minor axis was usually larger than 600 nm. The aspect ratio between the length of major and minor axes was around 2. Smaller nano-ellipses can be obtained by reducing the ultraviolet (UV) exposure. As illustrated in Figure S01, the length of the minor axis decreases from 400 nm to 250 nm when we reduce the UV exposure duration from 160 s to 60 s. It should be noted all the UV exposures reported in Figure S01 are not long enough to create opened photoresist (PR) holes. Both rotating oblique angle (OBL) deposition of Cr and oxygen plasma treatment are performed later in order to obtain opened PR holes. The deposition angle is 75°. The length of the major axis also becomes smaller from 700 nm to 400 nm. Therefore, the aspect ratio does not vary when we changes the UV exposure, as illustrated by

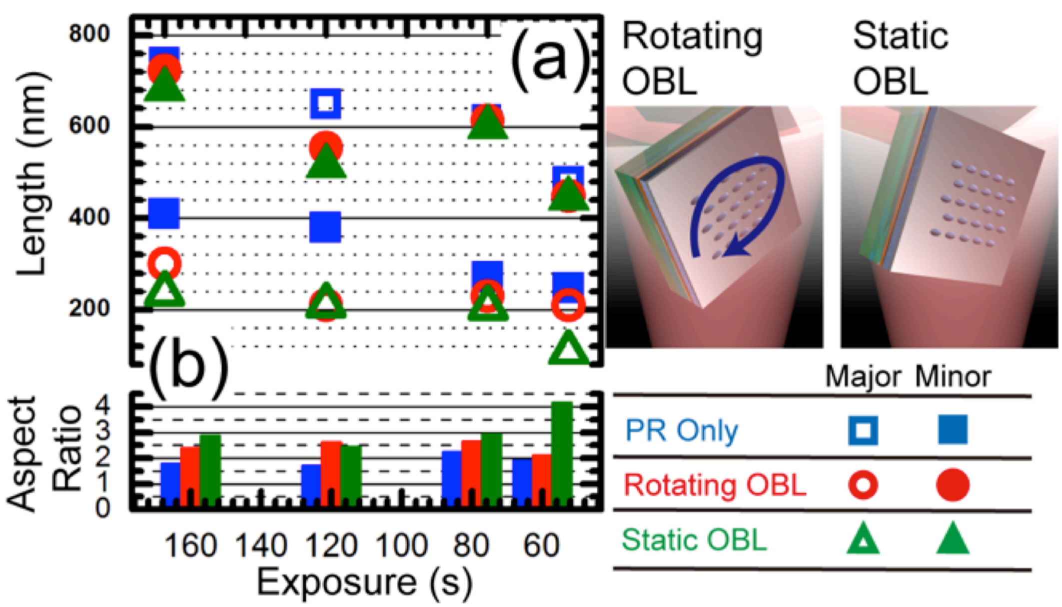

Figure S01: (a) The lengths of the major and minor axis for the nano-ellipses immediately after PR development, rotating OBL evaporation and static OBL evaporation. (b) The resulting aspect ratio of the nano-ellipse. Reducing the exposure effectively shrink the sizes of the ellipses but keep the same aspect ratio. By using static OBL evaporation, nano-ellipses with length of short axis smaller than 200 nm and aspect ratio higher than 4 can be obtained.

the blue bars in Figure S01(b). The length of the minor axis for these PR holes is significantly larger than 200 nm. But it is not practical to further reduce the UV exposure because both the major and minor axes become smaller. Holes with irregular shapes occur more frequently if the UV exposure is further reduced. If the deposition angle for the rotating OBL deposition is slightly reduced to 70°, the evaporated metal will start to deposit on the sidewall of the holes and shrink the holes. The results are marked as red in Figure S01 and the sizes of the PR holes for all four exposures are reduced after rotating OBL procedures. The aspect ratio only slightly increases to around 2.5. However, the length of the minor axis is still larger than 200 nm. Therefore, rotating OBL deposition at 70° along is not sufficient to achieve the necessary length for the minor axis. Instead of rotating while performing the rotating OBL deposition, the sample can also be static at a fixed angle (70°) so the major axis of the ellipses is perpendicular the evaporation direction. Using static OBL deposition, the length of the minor axis becomes smaller while the length of the major axis remains unchanged, which are marked in green in Figure 1. The length of the minor axis can be controlled down to 150 nm and the aspect ratio increases to around 4. The final Ni nano-ellipses we used later in this study exhibit a major axis length of 600 nm and minor axis length of 150 nm. The thickness of the nano-ellipse is around 70 nm.

SI-2. Transmission spectrum of the light-blocking layer

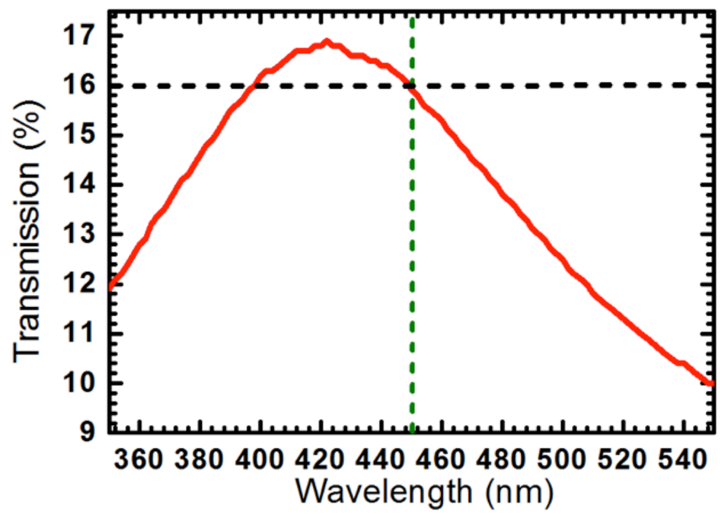

Figure S02: Transmission spectrum of the Ni (20 nm)/SiO_2 (140 nm) light blocking layer. The green dash lines indicates the LED emission wavelength around 450 nm.

SI-3. Complex Refractive Index of GaN and SiO_2

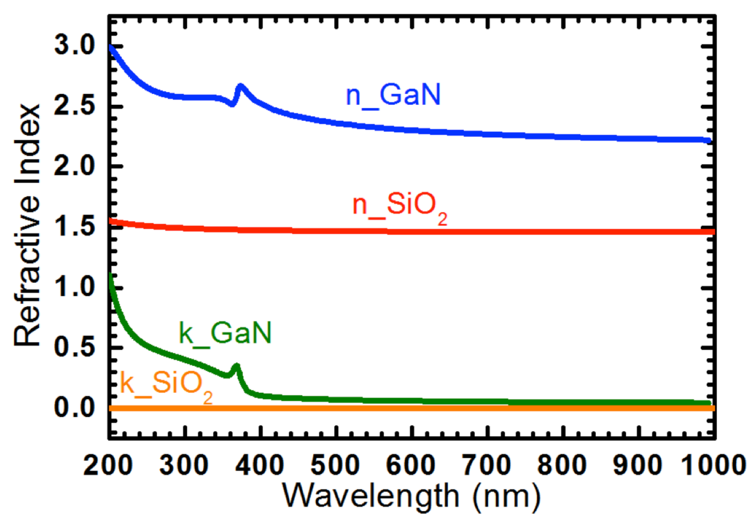

Figure S03: Complex refractive index of the GaN and SiO_2 between 200 nm and 1000 nm.

SI-4. Fabrication process of the light blocking and insulating layers

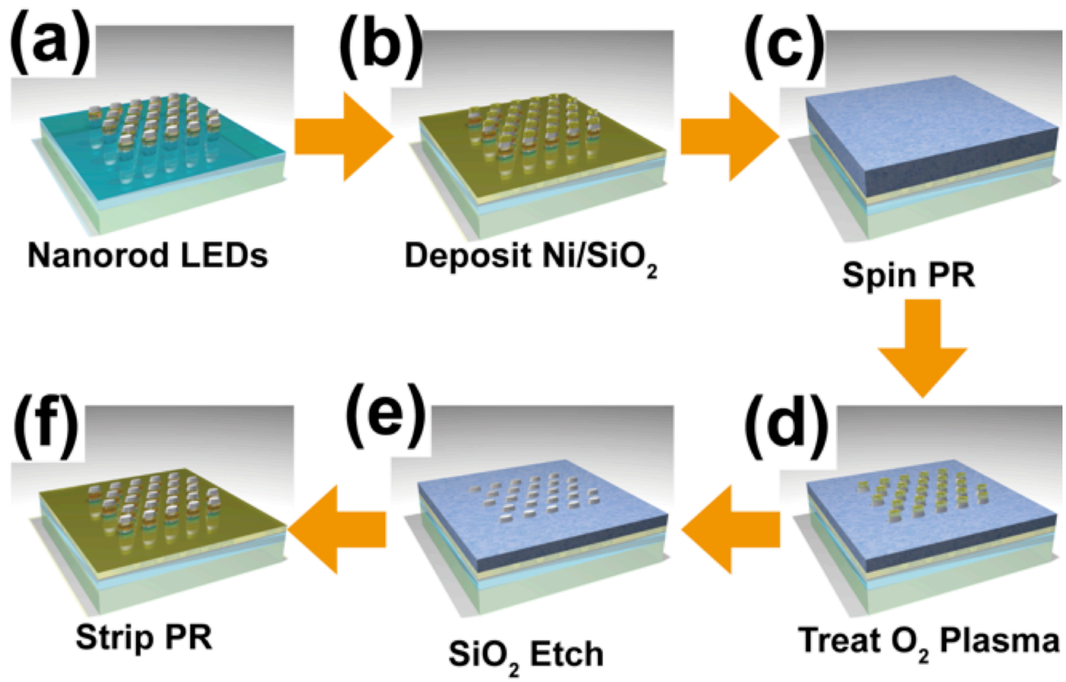

Figure S04: (a) - (f) Schematically illustrations of the fabrication procedures to deposit Ni and SiO_2 only onto the surface between nanorods.

SI-5. Fabrication procedures of the top metal electrode

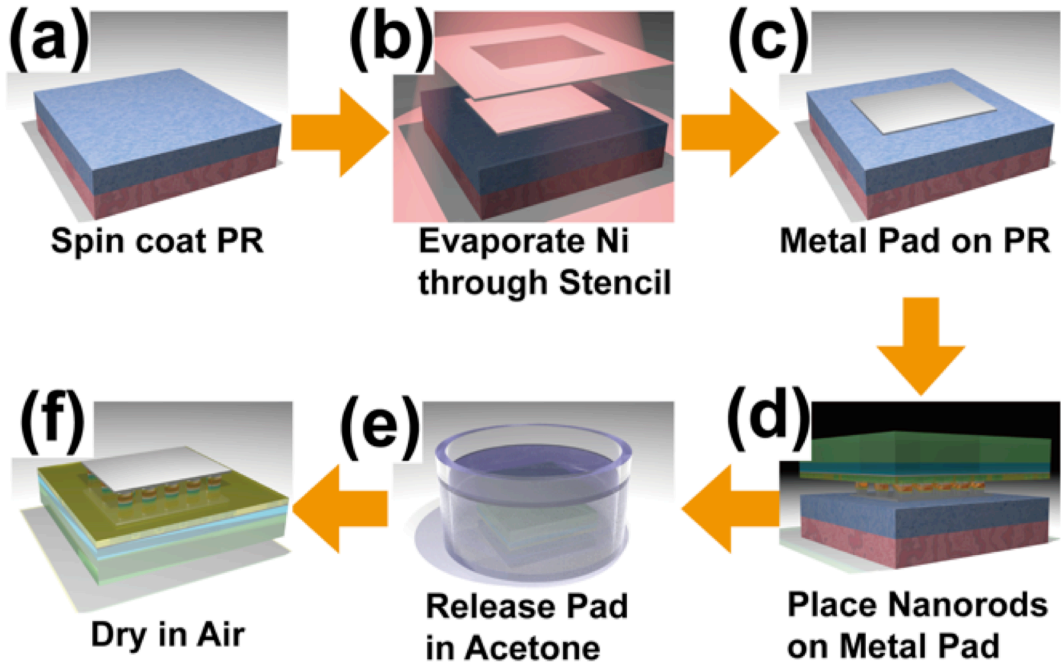

Figure S05: (a) - (f) Schematically illustrations of the fabrication procedures to preciously position Ni metal pads onto the nanorod LEDs.