SUPPLEMENTARY INFORMATION

Multispectral imaging with vertical silicon nanowires

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Fabrication process for multispectral filter, and method by which it is transferred to image sensor

The fabrication steps generally follow methods previously reported.[1, 2] Fabrication starts with etching vertical silicon nanowires. We pattern Al nanodisk arrays using ebeam lithography and lift-off. These are then used as etch masks for forming the nanowires by inductively coupled plasma reactive ion etching (ICP-RIE).[1] After that, we transfer the nanowires into the PDMS.[2] The higher PDMS curing temperature increases the adhesion between the PDMS and silicon and ensure that the nanowires remain within the PDMS film during the scraping process performed next.[2] We next remove the cover glass of the image sensor by melting the glue with a heat gun. We then mount the multispectral filter, comprising the PDMS film with embedded nanowires, onto the image sensor under a magnifier. These fabrication steps are described in detail below.

Fabrication steps

Nanowire fabrication

1. Clean a silicon wafer piece (size: 1 × 1 inch, orientation: <100>) with Acetone and Isopropyl alcohol (IPA)
2. Spin e-beam resist (MicroChem PMMA 495K A2, 4000 rpm, 45 sec)
3. Softbake at 180 °C for 3 min
4. Spin e-beam resist (MicroChem PMMA 950K A2, 4000 rpm, 45 sec)
5. Softbake at 180 °C for 3 min
6. E-beam lithography of nanodisk arrays (Elionix, ELS-7000)
7. Develop in 1:3 MIBK to IPA for 90 sec
8. Rinse with IPA for 30 sec
9. Evaporate aluminium (40 nm) using thermal evaporator
10. Immerse the wafer piece in Acetone for 1 day at room temperature (lift-off)
11. Rinse with IPA for 1 min
12. Etch silicon nanowires by ICP-RIE (STS company, SF_6: 60 sccm, C_4F_8: 160 sccm, 1200 W, etch rate ~ 60 nm / min)

Transferring nanowires into PDMS

13. Prepare PDMS (Sylgard 184 Silicone Elastomer Kit, ratio of base to curing agent is 5:1)
14. Mix it using centrifugal mixer (Thinky, ARE-250 Mixer)
15. Spin coat PDMS mixture onto the wafer piece with vertical silicon nanowires (1000 rpm, 60 sec)
16. Cure the PDMS film at 230 °C for 60 min on hot plate
17. Allow the wafer piece to cool down to room temperature

18. Scrape the PDMS film using razor blade (VWR, 55411-062, angle between the wafer and razor blade ~ 45 °)
19. Place the cut film (nanowire side up) on a cleaned glass slide
20. Cut the film to the appropriate size (i.e. 2 mm × 15 mm in our case)

Mounting of multispectral filter (PDMS with embedded nanowires) onto image sensor

21. Unscrew the printed circuit board (PCB) from casing of a camera (Imaging Source , DMK21AF04)
22. Cover the PCB with Kapton tape to protect everything but the image sensor chip from being heating
23. Melt glue between the cover glass and image sensor using a heat gun (Hakko, 850B)
24. Carefully remove the cover glass from the image sensor
25. Remove the Kapton tape and clean the surface of the image sensor with dust blower
26. Place multispectral filter (PDMS film containing nanowires) onto the image sensor under a magnifier (nanowire side down). Comment: be careful not to touch the bond wires of the image sensor.
27. Reassemble the PCB into the camera case

References

1. Seo, K. *et al.* Multicolored Vertical Silicon Nanowires. *Nano Lett.* **11**, 1851-1856 (2011).

2. Park, H., Seo, K. & Crozier, K. B. Adding colors to polydimethylsiloxane by embedding vertical silicon nanowires. *Appl. Phys. Lett.* **101**, 193107-193104 (2012).