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optical and wetting effects

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Publication date: 2015

Document Version
Peer reviewed version

Link back to DTU Orbit

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Scalable nanostructuring on polymer by a SiC stamp: optical and wetting effects

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# Outline

## Motivation
- Wafer-Scale nanostructuring of SiC stamp
- Replication of nanostructures on a polymer surface

## Fabrication
- Optical effects
- Wetting properties

## Conclusions
Motivation

Push performance of devices towards their optimum limits by controllable fabrication of interfaces at the nanoscopic level.

Polymer materials gain interest both as semiconductors and conductors due to their low cost.
Prerequisites

Fabrication of nanostructures that result in macroscale effects with reproducibility!

and....nanopattern definition must be:
• Rapid
• Low-cost
• Applicable on wafer scale-high throughput
## SiC nanostructuring: summary table

<table>
<thead>
<tr>
<th>Type of structures</th>
<th>Method</th>
<th>Average Reflectance (%)</th>
<th>Luminescence enhancement (from 10 to 80 degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodic</td>
<td>E-beam</td>
<td>1,01</td>
<td>104%</td>
</tr>
<tr>
<td>Semi-periodic</td>
<td>Self-assembly</td>
<td>1,62</td>
<td>67%</td>
</tr>
</tbody>
</table>

*Reference:
A cost effective method for SiC aperiodic nanostructuring
Combinatory masking

200nm
Ramping:
RIE conditions+

Al thickness

*Reference: A. Argyraki et al., Optical Materials Express 8(3) 2013.
Fabrication of different nanotopographies

Color texture changes due to nanostructuring
Optical properties: Reflection, Transmission

Average 25%

Average 5%

Average 0,5%

Average 37%

Average 33%

Average 13%
Scalability
### Summary table

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<tr>
<td>Semi-periodic</td>
<td>Self-assembly*</td>
<td>1.62</td>
<td>67%</td>
</tr>
<tr>
<td>Stochastic</td>
<td>Combinatory masking</td>
<td>0.50</td>
<td>165%</td>
</tr>
</tbody>
</table>

*Reference: Ou, H., Advances in wide bandgap SiC for optoelectronics, The European Physical Journal B*
Replication of nanostructures on polymer

Process flow:
- Hot embossing
  - SiC (with antistiction coating)
- Polymer foil by SiC master stamp
- Galvanization process
  - Ni Shim and following generations
- Hot embossing
  - Hot embossed polymer by Ni shim
- Thin film deposition
  - Thin Al coated nanostructure
Ni shim: generation
Nanostructured polymer surface
Color textures after nanostructuring on polymer

A thin Al layer (~40nm)
Optical and wetting properties after nanostructuring on polymer

- **Bare Polymer**
  - Average 68 degrees
  - Reflection: 11%
  - Transmission: 88%

- **Nano Polymer**
  - Average 123 degrees
  - Reflection: 5%
  - Transmission: 85%

- **Al Coated-Bare Polymer**
  - Average 75 degrees
  - Reflection: 3%
  - Transmission: 33%

- **Al Coated-Nano Polymer**
  - Average 132 degrees
  - Reflection: 88%
  - Transmission: 85%
Conclusions

• Demonstrated 2 inch wafer nanostructuring on polymer by a SiC stamp

• Color texture and transmittance of SiC surface was controlled by nanotopography applied

• Color texture and reflectance of polymer surface was significantly altered by nanostructuring and additional deposition of a thin Al layer

• Wetting properties of surfaces shifted after nanostructuring from hydrophilic to hydrophobic
Acknowledgment

Weifang Lu  Yiyu Ou  Paul Michael Petersen  Haiyan Ou
Thank you for your attention

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