Mass-positioning of nanodiamonds using squeegee technique

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Abstract
Problem:
To position nanodiamonds on-chip precisely and efficiently in order to increase interaction with nanoscale photonic structures.

Scope of work:
We fabricated nanostructures using both EBL and FIB and used the squeegee technique to position large scale arrays of NDs. We performed quantitative analysis to optimize the filling ratio i.e. the probability that every hole has a ND.

Results:
Using the squeegee technique, we achieved a 100% filling ratio in holes with diameters of 125nm. This technique has the advantage of being fast, simple, and inexpensive.

Introduction
Relevance:
Positioning nanodiamonds near nanophotonic structures is of vital importance for building integrated quantum systems [1].

Conventional Solutions:
Spincoating
- fast
- non-deterministic

Scanning probe technique [2]
- precise positioning
- time-consuming
- costly

New Solution:
Squeegee technique [3]
- precisely located
- mass-positioned

Process of nanodiamonds positioning
Nanostructure array fabrication:
Electron beam lithography
Photresist: ZEP
- E-beam write
- Develop

Nanodiamonds deposition:
- 40 μl droplet of nanodiamond suspension
- sweep with a cleanroom wipe

Slot waveguides
- SEM scan

Nanohole array after fabrication
Confocal microscopy
- 40 μl droplet of water

Nanohole after squeegee procedure

Analysis:
- Figure of merit = # of ND inside
- Filling ratio = # of nanoholes filled
  # of ND outside

Results

Conclusions
- Using Matlab and Ledit, we automated the EBL and FIB fabrication procedures which allowed us to create nanohole patterns and slot waveguides quickly and accurately
- best result: 100% filling ratio (optimal nanohole diameter: 125 nm)
- technique provides fast and cheap (filling thousands of holes in few hours)

Future plan
- use the developed positioning technique to fabricate nanophotonic structures with nanodiamonds

References

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