A METHOD FOR CREATING STRUCTURES OR DEVICES USING AN ORGANIC ICE RESIST

The invention relates to a method for creating an organic resist on a surface of a cooled substrate, the method comprising the steps of condensing a vapour into a solid film on the surface of the cooled substrate; patterning at least part of the solid film by exposing selected portions of said solid film to at least one electron beam thereby creating the organic resist on the surface of the cooled substrate in accordance with a predetermined pattern; wherein the created organic resist remains essentially intact at ambient conditions; and using the created organic resist as a mask for creating semiconductor structures and/or semiconductor devices.

Organic ice resists
Electron-beam lithography (EBL) is the backbone technology for patterning nanostructures and manufacturing nanodevices. It involves processing and handling synthetic resins in several steps, each requiring optimization and dedicated instrumentation in cleanroom environments. Here, we show that simple organic molecules, e.g. alcohols, condensed to form thin-films at low temperature demonstrate resist-like capabilities for EBL applications and beyond. The entire lithographic process takes place in a single instrument, and avoids exposing chemicals to the user and the need of cleanrooms. Unlike EBL that requires large samples with optically flat surfaces, we patterned on fragile membranes only 5-nm-thin, and 2 x 2 mm² diamond samples. We created patterns on the nm to sub-mm scale, as well as three-dimensional structures by stacking layers of frozen organic molecules. Finally, using plasma etching, the organic ice resist (OIR) patterns are used to structure the underlying material, and thus enable nanodevice fabrication.
Publication information
Journal: Nano Letters
ISSN (Print): 1530-6984
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 13.4
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 14.76
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 14.04
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 14.23
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 13.78
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 13.83
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Original language: English
Electron-beam lithography, Condensed organic molecules, Ice lithography, Focused electron-beam induced deposition, 3D lithography, Nanostructured diamond
DOIs:
10.1021/acs.nanolett.7b04190
Source: FindIt
Source-ID: 2393552100
Publication: Research - peer-review › Journal article – Annual report year: 2017

Advances in Ice Lithography in Denmark and China

General information
State: Published
Organisations: DTU Danchip, Center for Electron Nanoscopy, Zhejiang University
Authors: Tiddi, W. (Intern), Zhao, D. (Ekstern), Qiu, M. (Ekstern), Beleggia, M. (Intern), Han, A. (Intern)
Publication date: 2016
Event: Abstract from 42nd International conference on Micro and Nano Engineering, Vienna, Austria.
Main Research Area: Technical/natural sciences
Ice lithography: water-based nanopatterning

Integration of ring nanoelectrodes into microwells for the bioelectrochemical analysis in sub-picolitre volumes

In this work, we report the fabrication and the electrochemical characterization of recessed disk micro-electrodes (DME) and ring nanoelectrodes (RNE) integrated in micowell arrays. Such configuration has all advantages of microelectrodes arrays but is more suitable for electrochemical measurement in sub-picolitre volumes (~0.3 pL). The technological process based on the reactive ion etching of a SiO2/Ti/Pt/Ti/SiO2 stack is optimized in order to integrate RNE arrays on transparent glass substrate. Multiphysic simulations and electrochemical characterizations are conducted in order to study and improve the amperometric behaviour of recessed ring nanoelectrodes according to their geometry. A good fit shown between experimental, theoretical and simulation results, allowing full understanding of the electrochemical detection properties of RNE-based micowell arrays. Then, a “generation – collection mode” chronoamperometric approach is proposed to evaluate experimentally the collection ratio of RNE arrays and compare it with simulation results. Finally, first electrochemical characterizations in sub-picolitre volumes are conducted with anti-oxidant species. All these results demonstrate that recessedring nanoelectrode arrays are fitted to the detection of bio-electrochemical species at the microscale and, consequently to single mitochondrion or single sub-cellular organelle analysis.
Water vapor is condensed onto a cold sample, coating it with a thin film of ice. The ice is sensitive to electron beam lithography exposure. 10 nm ice patterns are transferred into metals by “melt-off”. Non-planar samples are coated with ice, and we pattern on cantilevers, AFM tips, and suspended nanotubes.

**General information**

*State:* Published  
*Organisations:* DTU Danchip, Center for Electron Nanoscopy, Harvard University, Stanford University  
*Authors:* Han, A. (Intern), Kuan, A. (Ekstern), Wang, J. (Ekstern), Vlassarev, D. (Ekstern), Golovchenko, J. (Ekstern), Branton, D. (Ekstern), Tiddi, W. (Intern), Beleggia, M. (Intern)  
*Number of pages:* 2  
*Publication date:* 2015  
*Event:* Abstract from 5th Conference on Advances in Optoelectronics and Micro/Nano-optics, Hangzhou, China.
Proximity Effects in a Chemically Amplified Electron Beam Resist Patterned at 100 keV

**General information**
State: Published
Organisations: DTU Danchip, Center for Electron Nanoscopy
Authors: Tiddi, W. (Intern), Greibe, T. (Intern), Beleggia, M. (Intern), Han, A. (Intern)
Number of pages: 1
Publication date: 2015
Main Research Area: Technical/natural sciences
Electron beam lithography, Chemically amplified resist, Negative resist, Promixity effects

**Proximity Effects in a Chemically Amplified Electron Beam Resist Patterned at 100 keV**

**General information**
State: Published
Organisations: DTU Danchip, Center for Electron Nanoscopy
Authors: Tiddi, W. (Intern), Greibe, T. (Intern), Beleggia, M. (Intern), Han, A. (Intern)
Number of pages: 1
Publication date: 2015

**Host publication information**
Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark (DTU)
Article number: P-12
Main Research Area: Technical/natural sciences
Conference: DTU Sustain Conference 2015, Lyngby, Denmark, 17/12/2015 - 17/12/2015

**Projects:**

**Ice lithography for large-scale sub-10 nm patterning**
Department of Physics
Period: 15/12/2014 → 14/02/2018
Number of participants: 3
Phd Student:
Tiddi, William (Intern)
Supervisor:
Han, Anpan (Intern)
Main Supervisor:
Beleggia, Marco (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

**Ice lithography**

DTU Danchip

Center for Electron Nanoscopy

Period: 01/12/2014 → 01/12/2017

Number of participants: 3

Project participant:

Han, Anpan (Intern)

Tiddi, William (Intern)

Main Supervisor:

Beleggia, Marco (Intern)

Project