

Nanotechnologies and Nanoelectronics

2021-semestre 1-P2

**Homework #1**

The work should be sent to: [susana.freitas@tecnico.ulisboa.pt](mailto:susana.freitas@tecnico.ulisboa.pt)

Deadline: 17 December 2021 @ 23:59[[1]](#footnote-1).

Please send the work in one single file[[2]](#footnote-2) (e.g., pdf, jpeg, word)

identified as: **NN2021\_YourName\_HW1**

1- Search for **3 examples of ideas** that were awarded with a Nobel Prize related to Nanotechnologies and Nanoelectronics (materials, techniques, physical principles,...) and fill the following tables (MAX 1 page each table):

|  |  |
| --- | --- |
| #1  Nobel Awardee(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Year:\_\_\_\_\_\_\_\_\_\_\_\_ | |
| Nobel Prize in | Chemistry / Physics / Medicine |
| Brief description of the scientific idea | |
| Explain its relevance for the Nanotechnologies and/or Nanoelectronics area | |
| How the scientific idea was implemented in one device, instrument or equipment (provide one example, if any) | |

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| #2  Nobel Awardee(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Year:\_\_\_\_\_\_\_\_\_\_\_\_ | |
| Nobel Prize in | Chemistry / Physics / Medicine |
| Brief description of the scientific idea | |
| Explain its relevance for the Nanotechnologies and/or Nanoelectronics area | |
| How the scientific idea was implemented in one device, instrument or equipment (provide one example, if any) | |

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| #3  Nobel Awardee(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Year:\_\_\_\_\_\_\_\_\_\_\_\_ | |
| Nobel Prize in | Chemistry / Physics / Medicine |
| Brief description of the scientific idea | |
| Explain its relevance for the Nanotechnologies and/or Nanoelectronics area | |
| How the scientific idea was implemented in one device, instrument or equipment (provide one example, if any) | |

2- Write a summary table (MAX 1 page each, including figures) with the key information on some technologies supporting the Nanoelectronics.

|  |  |
| --- | --- |
| 1. Electron-beam lithography – method using an electron beam (e-beam) to irradiate selectively a surface and generate nanometric-sized features | |
| Describe the principle of operation of an e-beam lithography system | [insert figures here, including a detail on the beam focusing and deflection] |
| Search and list some relevant Patents related to e-beam systems for nanotechnology usage | |
| Describe the physical mechanisms to write e.g., 200nm features using an-e-beam lithography tool. | |
| Discuss the physical limits to reduce the size towards 10nm feature sizes. | |
| Provide one example of a commercial device or component for nanoelectronics/nano-optics that could have been produced using e-beam lithography. | |
| Explain the limitations in using an e-beam lithography tool to write millions of nano-elements in a 300mm diameter wafer, in case this is a technology compatible with transistor fabrication. | |
| *References*: | |

|  |  |
| --- | --- |
| 1. Thin film deposition by sputtering – physical method used to deposit thin films (< 100nm thick) on a substrate | |
| Describe the principle of operation of a sputtering deposition system | [insert figures here, including a typical geometry of a sputtering chamber |
| How the pressure of the sputtering gas affects the film quality and sputtering rate? | |
| Explain how the film quality can be affected by the substrate and/or underlayer interface quality. | |
| Discuss the physical limits to reduce the minimum layer thickness (for a continuous layer) below 0.3nm – i.e., to deposit a continuous monolayer. | |
| Provide one example of a commercial device or component for nanoelectronics/nano-optics that could have been produced using magnetron sputtering, in a 300 mm diameter wafer. | |
| *References:* | |

|  |  |
| --- | --- |
| 1. Scanning probe microscopy – physical method used to create a surface map of a substrate | |
| Describe the principle of operation of a scanning force microscopy system | [insert figures here, including a typical geometry of a scanning force microscope] |
| How can we use it for the measurement of the surface roughness? | |
| Explain how the surface mapping can be affected by the substrate material (describe, in particular: i) conductive vs non-conductive materials and ii) magnetic materials and iii) organic/soft materials) | |
| Discuss the physical limits of the measurement (e.g., minimum dimension resolved, maximum area mapped…) | |
| Provide one example of a commercial device or component for nanoelectronics/biotechnology that was highly improved thanks to the scanning probe techniques. | |
| *References:* | |

1. The documents received up to 5 days after the deadline will have a penalty of 1 point (out of 20) per day. No documents will be accepted after the 6th day. [↑](#footnote-ref-1)
2. In case you need to have pictures of hand-written work, or multiple format digital formats for your solutions, please merge them into one single document. [↑](#footnote-ref-2)