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CNTs patterning using silicon shadow mask as template for chemical free and cost-effective fabrication of device array

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1. The title should be as brief as possible but long enough to indicate clearly the nature of the study. Capitalise the first letter of the first word ONLY (place names excluded). No full stop at the end.
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Introduction: Clearly state the purpose of the abstract
Methods: Describe your selection of observations or experimental subjects clearly
Results: Present your results in a logical sequence in text, tables and illustrations
Discussion: Emphasize new and important aspects of the study and conclusions that are drawn from them

Introduction

Patterning of carbon nanotubes (CNTs) is prerequisite for different applications such as thin film transistors, sensors, field emission displays, and molecular-filtration membranes [1]. The reported techniques such as photolithography, laser based photo-ablation, inkjet printing, chemical vapor deposition (CVD), and dip-pen nanolithography either involve complicated fabrication processes, use of various chemicals, or preconditioning the substrate/AFM tips etc. [2]. In these processes, even remaining residues of chemicals like photoresist, etchant etc. can affect the electrical properties of CNTs, which leads to the variations in the characteristics of fabricated devices/sensors. In this work, fabricated reusable silicon shadow mask as template provide chemical free patterning of single walled CNTs (SWCNTs) in isolated areas and it would also reduce the overall fabrication cost.

Method

Schematic diagram for complete fabrication process flow of silicon shadow mask is illustrated in Figure 1(a). Windows of 400µm x 400µm were defined via bulk micro-machining using TMAH (25% wt) solution at 80°C with silicon etch rate of ~24µm/h. Fabricated shadow mask is shown in Figure 1(b). Silicon mask, clamped on another oxidized silicon wafer was kept over hot plate and SWCNTs (in 1,2 Dicholorobenzene) were spray coated under optimized conditions reported earlier [3]. After spray, silicon shadow mask can be reused as template for next set of patterning.

Results and Discussion

Optical image of SWCNTs pattern is shown in Figure 1(c). FESEM image (Figure 2(a)) confirms the isotropic spray of SWCNTs over prefabricated source-drain structure and are not beyond ~750µm diameter. Raman mapping image (Figure 2(b)) of 1.6mm x 3.2mm area, corresponds to RBM peak range 168-172cm^{-1}, which also ensures isolation of sprayed SWCNTs patterns, therefore it will not interfere with nearby devices/sensors.

Conclusions

Fabricated silicon template has been demonstrated as simple, cost-effective and chemical-free technique to pattern SWCNTs, useful to fabricate array of devices/sensors over large size wafer.

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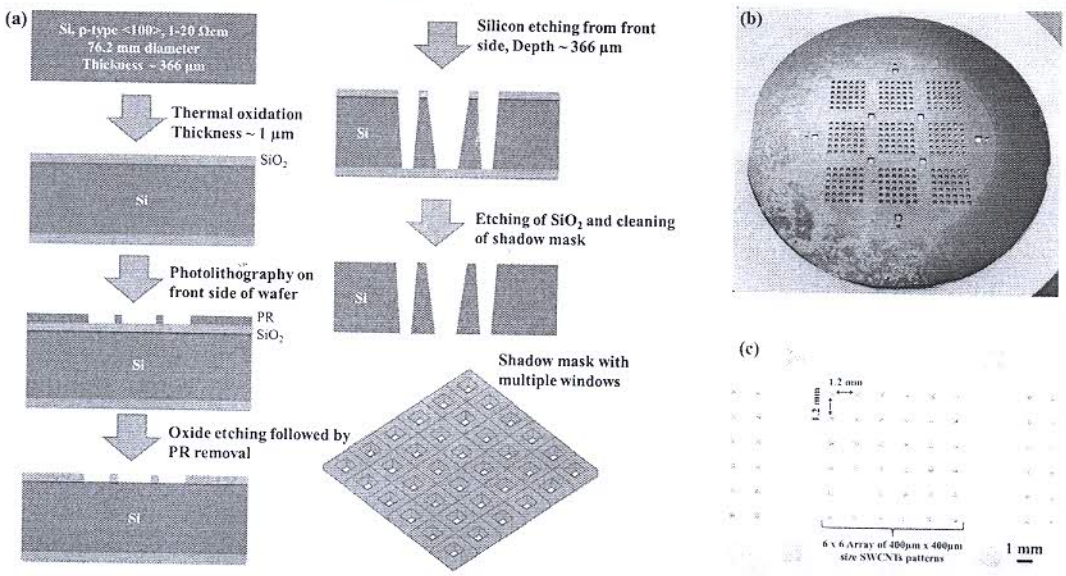

Figure 1: (a) Process flow chart of silicon shadow mask fabrication, (b) fabricated shadow mask, and (c) optical image of large area, showing the patterned SWCNTs after spray coating.

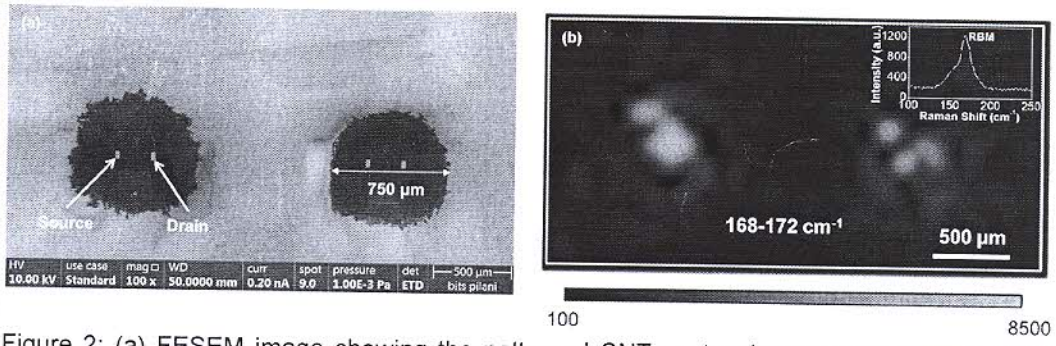

Figure 2: (a) FESEM image showing the patterned CNTs network over prefabricated source-drain pairs at two locations, and (b) Raman map image (corresponding to RBM peak in 168-172 cm^{-1} range) confirms isolated SWCNTs patterns; inset shows RBM peak in Raman spectra at typical patterned location.

Acknowledgement

Director, CSIR-CEERI, Dr. Ajay Agarwal, and CSIR for financial support.

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