Thermoelectric Property of Silicon Nanowires Processed by Metal Assisted Directional Chemical Etching

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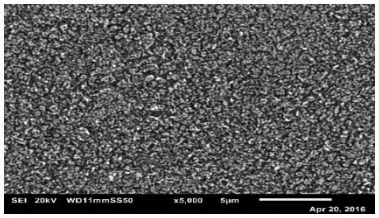
Objectives

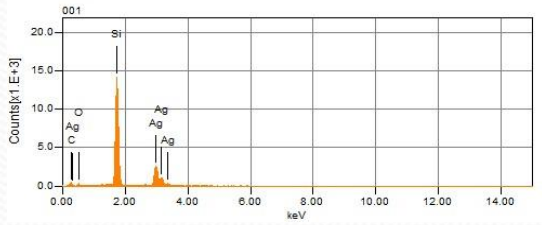
◊ To prepared silicon single crystal nanofibers using a silver induced self-catalysis chemical etching process
◊ To test the thermoelectric property of the silicon nanofiber

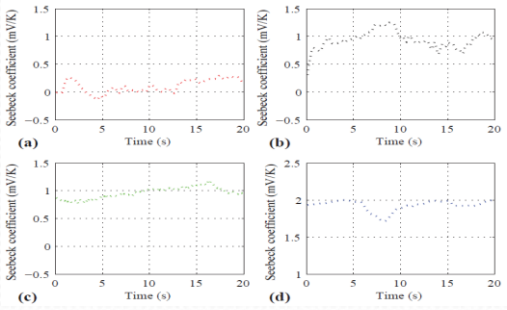
Background

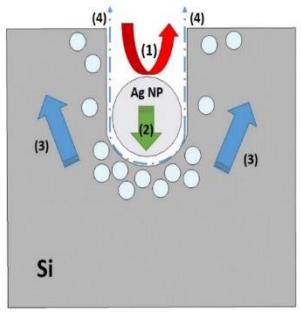
◊ Thermoelectric (TE) materials offer the opportunity for direct conversion of heat into electrical power from temperature differences.
◊ Semiconducting materials are often used in TE units because they have high power factors.
◊ Silicon has been extensively studied because of the relatively low cost and high figure of merit.
◊ Si is compatible with oxide/metallic connecting electrode materials.
◊ Nanostructured Si in the form of thin film or nanowire (NW) has higher energy conversion efficiency than bulk silicon.
◊ Si NW is often processed by E-beam lithography and chemical vapor deposition (CVD); self-catalysis chemical etching is a new process.

Results and Discussion





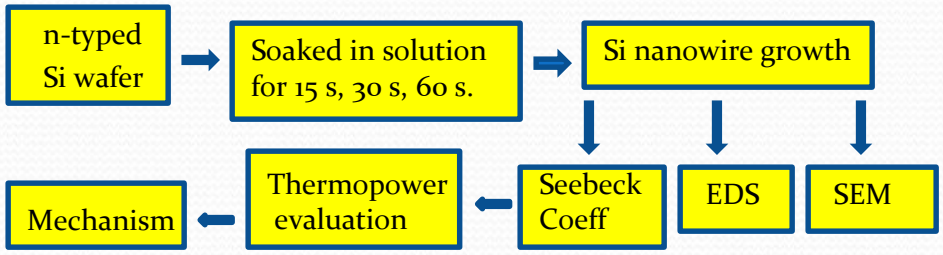




Materials and Instruments

◊ <100> n-type Si wafer pieces with the thickness of 500 micron
◊ Solution: 0.01 M $AgNO_3$, 0.2 M H_2O_2 and 4.8 M HF
◊ CHI 440C electrochemical workstation for measuring TE property
◊ Jeol JSM-6010PLUS/LA SEM with energy dispersive X-ray spectroscopy

Approaches



Conclusions

◊ SiNWs were successfully synthesized by first depositing Ag NPs onto n-type Si wafer and secondly implementing the MaCE technique.
◊ The Seebeck coefficient of the SiNWs is three times higher than that of the original Si wafer.
◊ The SiNW with thermoelectric performance improvement is promising for the next generational thermoelectric devices.

Acknowledgements

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