

The effect of metal halides and metal chalcogenides, such as iron chloride, cobalt chloride, and bismuth telluride, on the morphology and electronic properties of single-walled carbon nanotubes

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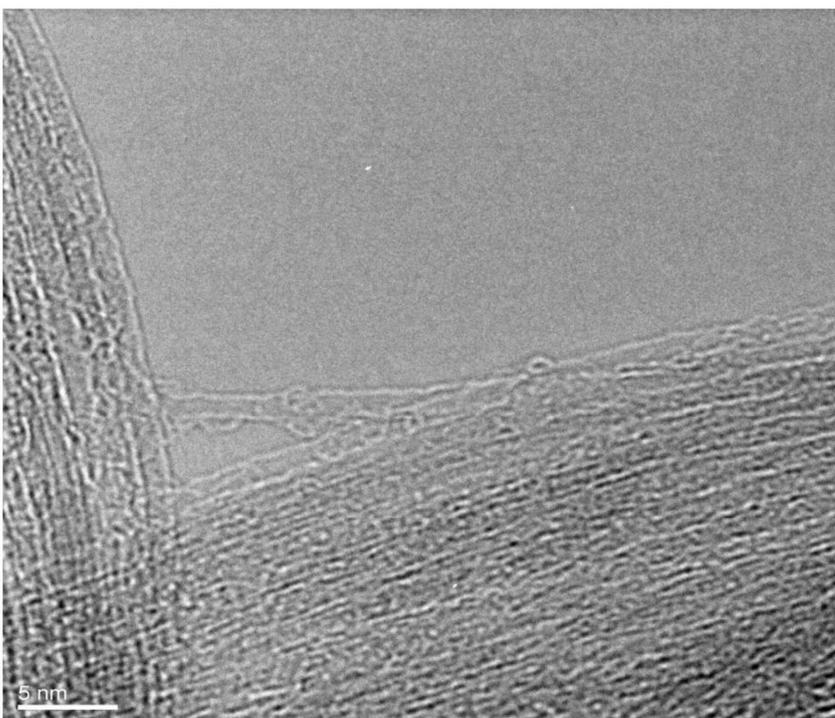
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INTRODUCTION & AIM

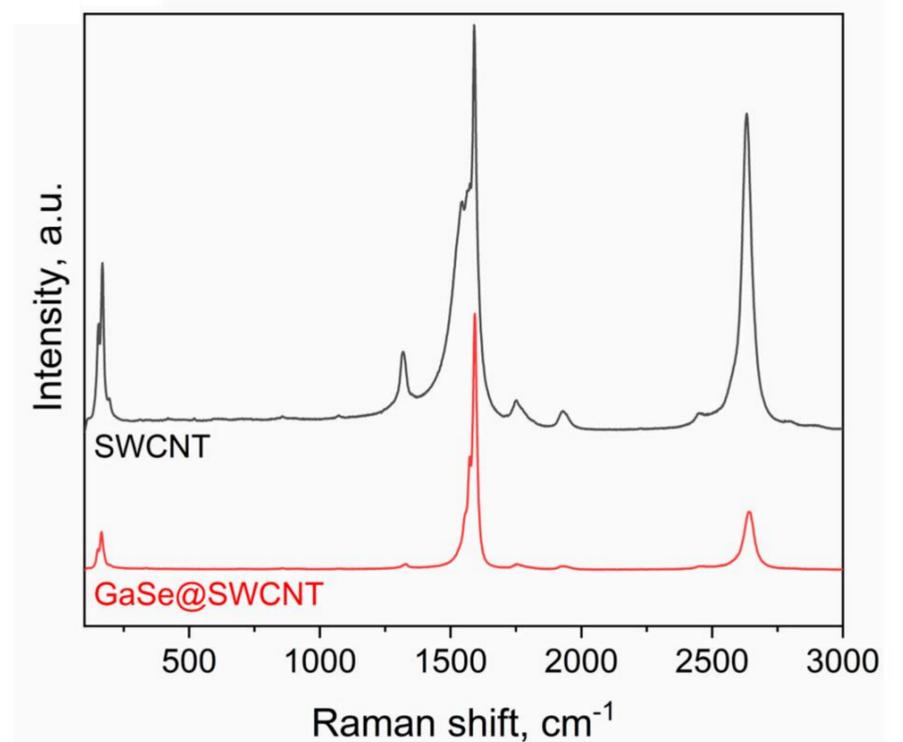
The loading of single-walled carbon nanotubes (SWCNTs) is very important for applications. Loading methods include loading from the gas phase, as well as the liquid phase—melted compounds and solutions. It was demonstrated that the incorporated substances form new, interesting properties and phases inside SWCNTs. Spectroscopic techniques, such as Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), optical absorption spectroscopy (OAS), and near-edge X-ray absorption fine structure spectroscopy (NEXAFS), were utilized. It was shown that the incorporated substances may cause the p- and n-doping of the SWCNTs [1, 2].

METHOD

I have encapsulated new compounds, such as iron chloride (FeCl_2), cobalt chloride (CoCl_2), and bismuth telluride (Bi_2Te_3), inside SWCNTs. The loading was investigated by high-resolution transmission electron microscopy (HRTEM), and it was proven that the interior space within the SWCNT walls was loaded.



The HRTEM image of gallium selenide-filled SWCNTs [3]. Copyright 2023 by the authors. Licensee: MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.



The Raman spectra of GaSe-filled SWCNTs acquired at laser wavelength of 633 nm [3]. Copyright 2023 by the authors. Licensee: MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

CONCLUSION

The incorporated substances formed crystalline phases inside the SWCNTs. The spectroscopic investigations showed that iron chloride and cobalt chloride led to p-doping of the SWCNTs. This was observed as the changes in the shapes of the Raman modes, shifts in the C 1s XPS on the lower-binding-energy side, the appearance of additional peaks in the C 1s NEXAFS, and the disappearance of peaks in the OAS spectra.

FUTURE WORK / REFERENCES

- [1] Kharlamova M.V. Lead Halogenide Filled Single-Walled Carbon Nanotubes. Eng. Proc. 2023, 37, 45.
- [2] Kharlamova M.V. Photoemission Insight to Filling of Large 1.7 nm Diameter Single-Walled Carbon Nanotubes with Silver Chloride. Eng. Proc. 2023, 37, 46.
- [3] Kharlamova M.V. Gallium Selenide and Rubidium Iodide Filling of Single-Walled Carbon Nanotubes as p, and n-Dopant Chemical Compounds. Eng. Proc. 2023, 37, 49.