

## Ferrocenes inside single-walled carbon nanotubes

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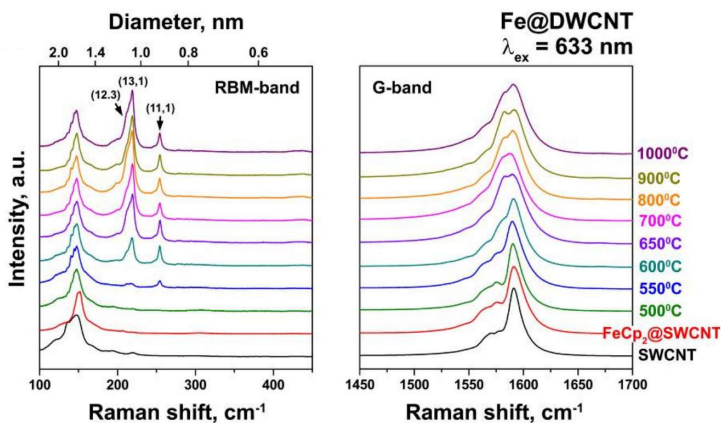
### INTRODUCTION & AIM

It is of paramount importance to create applications for SWCNTs in automation and control systems. Ferrocene-filled single-walled carbon nanotubes (SWCNTs) are interesting systems with unique properties. SWCNTs were first filled with ferrocene in 2005 [1]. Since then, many more studies have dealt with the filling of SWCNTs with ferrocenes. The structures of ferrocenes in SWCNTs with different diameters have been investigated [2]. The growth dynamics of inner carbon nanotubes inside ferrocene-filled SWCNTs attract the interest of researchers [3].

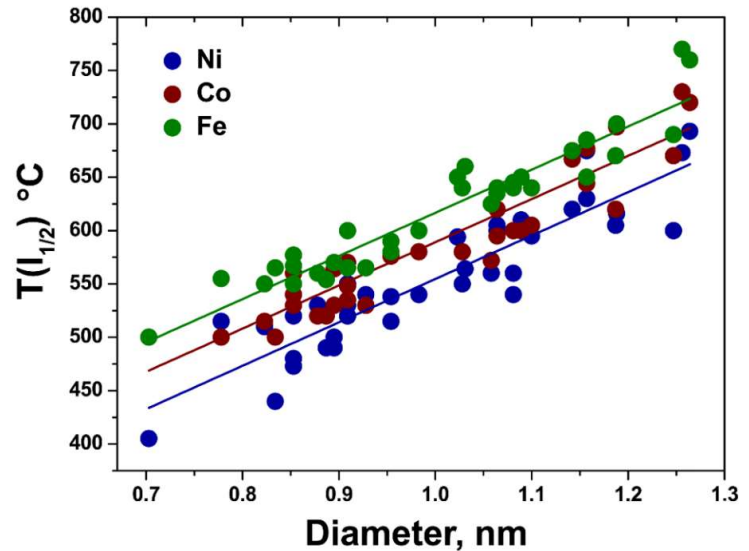
### METHOD

Controlling the physics of ferrocene-filled SWCNT systems opens up superior possibilities. The outer diameter of SWCNTs is well defined. This controls the size of catalyst particles inside SWCNTs. This shows great promise for new applications in automation and control systems. In this paper, the preparation of ferrocene-filled SWCNTs allowed us to control the physics of the interior of carbon nanotubes. The growth dynamics and electronic properties of carbon nanotubes were investigated with spectroscopy. The growth rates of three carbon nanotubes were compared. The Fermi level differences in pristine SWCNTs and samples of vacuum-annealed, ferrocene-filled SWCNTs were shown.

### RESULTS & DISCUSSION



The Raman spectra of the ferrocene-filled, and annealed SWCNTs [4]. Copyright 2021 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 growth temperatures of nickelocene-, cobaltocene-, and ferrocene-filled SWCNTs [4]. Copyright 2021 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

In this work, the inner SWCNTs were growth inside the ferrocene-filled SWCNTs. The growth dynamics of inner SWCNTs with chiralities of (12,3), (13,1), and (11,1) was traced in the Raman spectra of the ferrocene-filled, and annealed SWCNTs. It was demonstrated that the growth properties of inner SWCNTs depend on the diameter of SWCNTs. The growth properties of inner SWCNTs were compared for nickelocene-, cobaltocene-, and ferrocene-filled SWCNTs. It was shown that the growth temperatures of inner SWCNTs are larger for larger diameter SWCNTs, and they increase from nickelocene to cobaltocene to ferrocene. This opens a range of applications of ferrocene-filled SWCNTs.

### FUTURE WORK / REFERENCES

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