

# Molecular 2D materials by self-assembly and electron irradiation induced conversion of linear three-ring aromatic thiols

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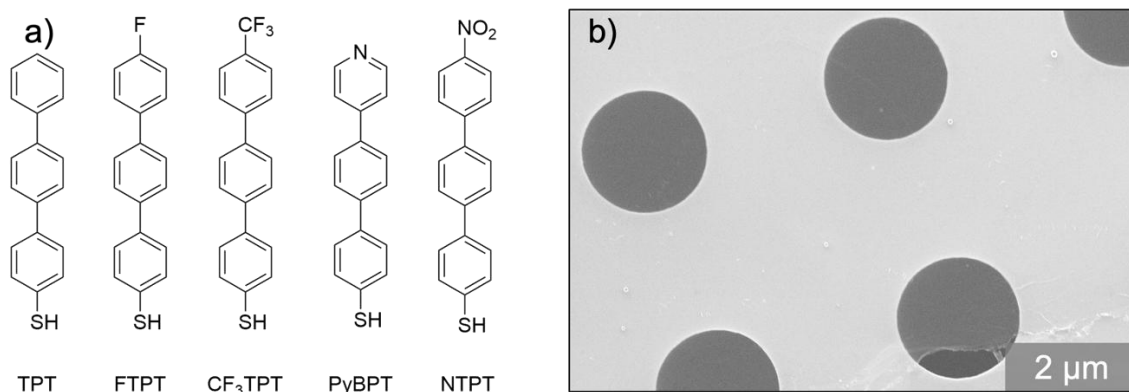
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Molecular two-dimensional (2D) materials derived from self-assembled monolayers (SAMs) provide a versatile platform for designing ultrathin membranes with tuneable permeation properties [1-2]. Here, we demonstrate the controlled fabrication of ~ 1 nm thick carbon nanomembranes (CNMs) via low-energy electron-induced crosslinking of linear, three-ring aromatic thiols assembled on Au substrates. By systematically varying the terminal functional groups of terphenylthiol (TPT) derivatives (-F, -CF<sub>3</sub>, -NO<sub>2</sub>) and investigating a pyridine-terminated biphenyl analogue (see Figure 1), we establish correlations between precursor chemistry, monolayer structure, and nanomembrane performance. Comprehensive surface characterization using X-ray photoelectron spectroscopy (XPS), low-energy electron diffraction (LEED), and scanning tunneling microscopy (STM) reveals how modifications in the molecular structure govern the structure of the formed SAMs [3]. These structural differences translate into distinct nanoporosity characteristics in the resulting CNMs. Gas permeation measurements for He, D<sub>2</sub>, and D<sub>2</sub>O between room temperature and 100 °C demonstrate tuneable transport properties and pronounced selectivity within the D<sub>2</sub>O/D<sub>2</sub> pair. Our results identify molecular design principles that enable precise control over sub-nanometer porosity in 2D carbon nanomembranes, advancing their potential for selective gas separation.

## References

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- [2] V. Stroganov, T. Nöthel, D. Hüger, M. Kruk, C. Neumann, K. Koziel, P. Cyganik, A. Turchanin, *Small* 20 (2024) 2406526.
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## Figures



**Figure 1:** a) Molecular structures of utilized precursor molecules: 1,1',4',1''-terphenyl-4-thiol (TPT), 4''-fluoro-[1,1':4',1''-terphenyl]-4-thiol (FTPT), 4''-(trifluoromethyl)-[1,1':4',1''-terphenyl]-4-thiol (CF<sub>3</sub>TPT), 4''-(pyridin-4-yl)-[1,1'-biphenyl]-4-thiol (PyBPT), and 4''-nitro-[1,1':4',1''-terphenyl]-4-thiol (NTPT). b) Scanning electron micrograph of the NTPT CNM placed on a TEM grid.