Stationary Phases in Gas Chromatography

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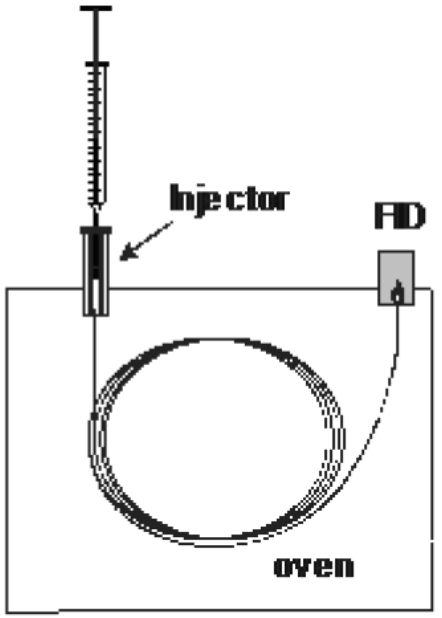
Gas Chromatography (GC)

- Chromatography: Separation of chemicals by changing velocity
- GC: Chromatography with gas carrier
  - Interaction with stationary phase and volatility changes velocity
- Effects of stationary phase on GC
  - Type of column chosen
  - Compound chosen for stationary phase

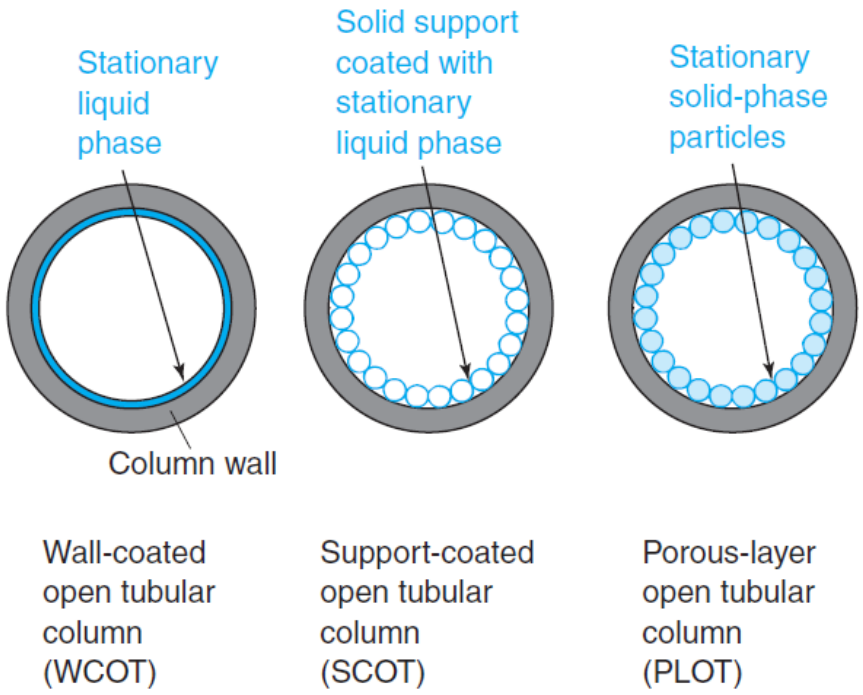


Columns Used in GC

- Columns
  - Carrier gas passes through GC columns
  - Stationary phase lining columns interact with analyte
- Packed Columns
  - Contains particles of porous solid
  - Can be coated with liquid stationary phase, or can be by itself
- Open Tubular (capillary) columns
  - Stationary phase lines walls of column
  - Also allows liquid or solid stationary phases

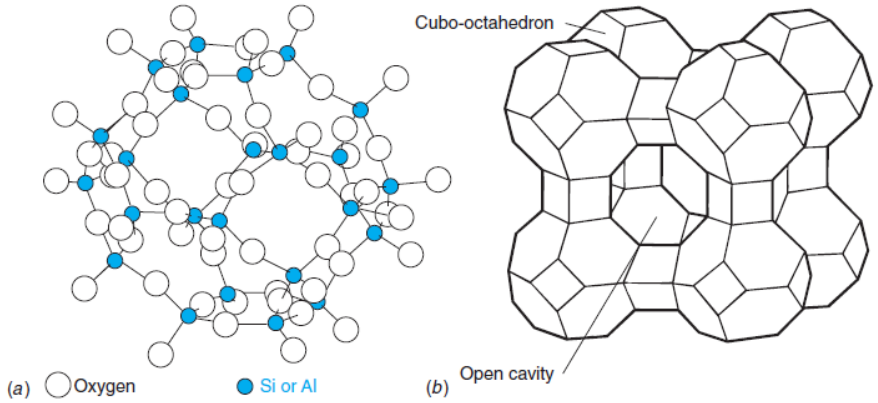
Types of Open Tubular Columns

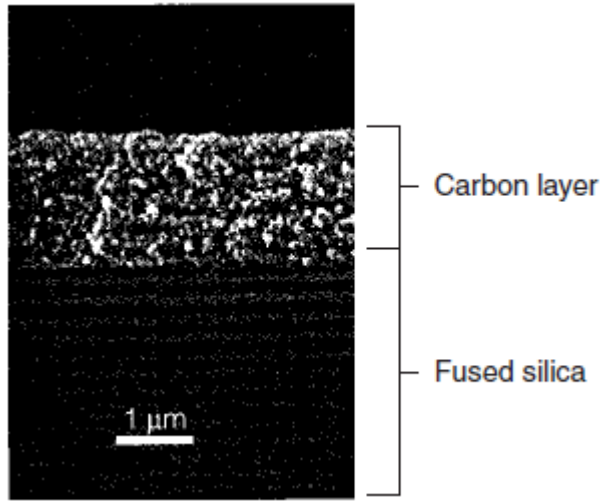
- Wall-coated open tubular column (WCOT)
  - Column wall is coated with liquid stationary phase
- Support-coated open tubular column (SCOT)
  - Column wall is coated with solid particles
  - Particles are coated with liquid stationary phase
- Porous-layer open tubular column (PLOT)
  - Column wall is coated with solid particles
  - Solid stationary phase



Solid Stationary Phases

- Porous polymers, high surface-area carbons or Alumina (Al_2O_3)
  - Used for separating hydrocarbons
- Molecular sieves
  - Can retain small molecules
  - Separates molecules like H_2, O_2, N_2, CO_2, CH_4





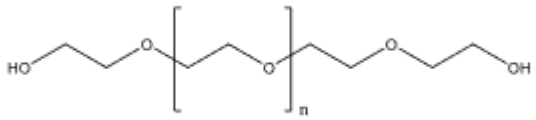
Polarity of Liquid Stationary Phases

- Polarity of stationary phase affects separation quality
- Based on concept of “like dissolves like”
  - Polar stationary phases will interact more with polar compounds
  - Vice-versa is true
- “Like” compounds will be separated more effectively
  - Polar compounds will interact more with polar stationary phase
  - Two compounds with similar boiling points can be separated
- Choice is dependent on compounds in mixture

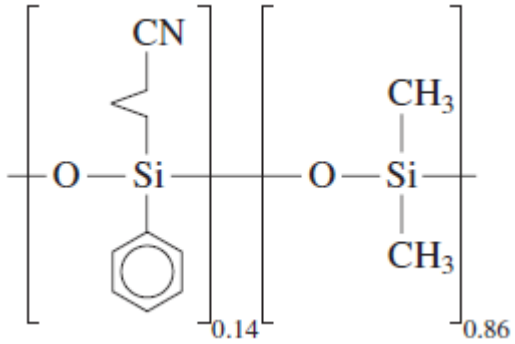
Examples of compounds used

Polar compounds

- Polyethylene glycol

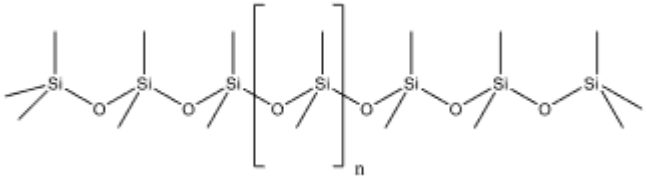


  - Strongly polar
- $(\text{Cyanopropylphenyl})_{0.14}(\text{dimethyl})_{0.86}$ polysiloxane
  - Intermediate polarity

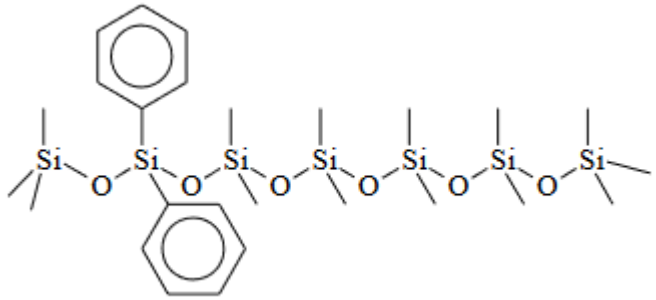


Nonpolar compounds

- Dimethyl-polysyloxane

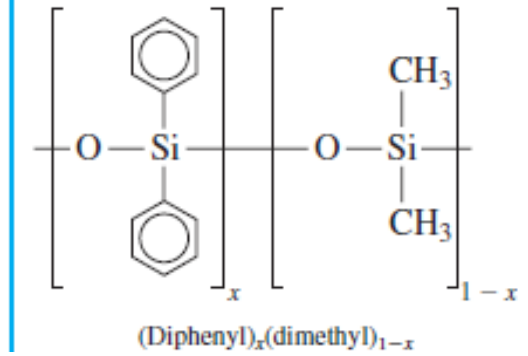


- (Diphenyl)(dimethyl)-polysyloxane



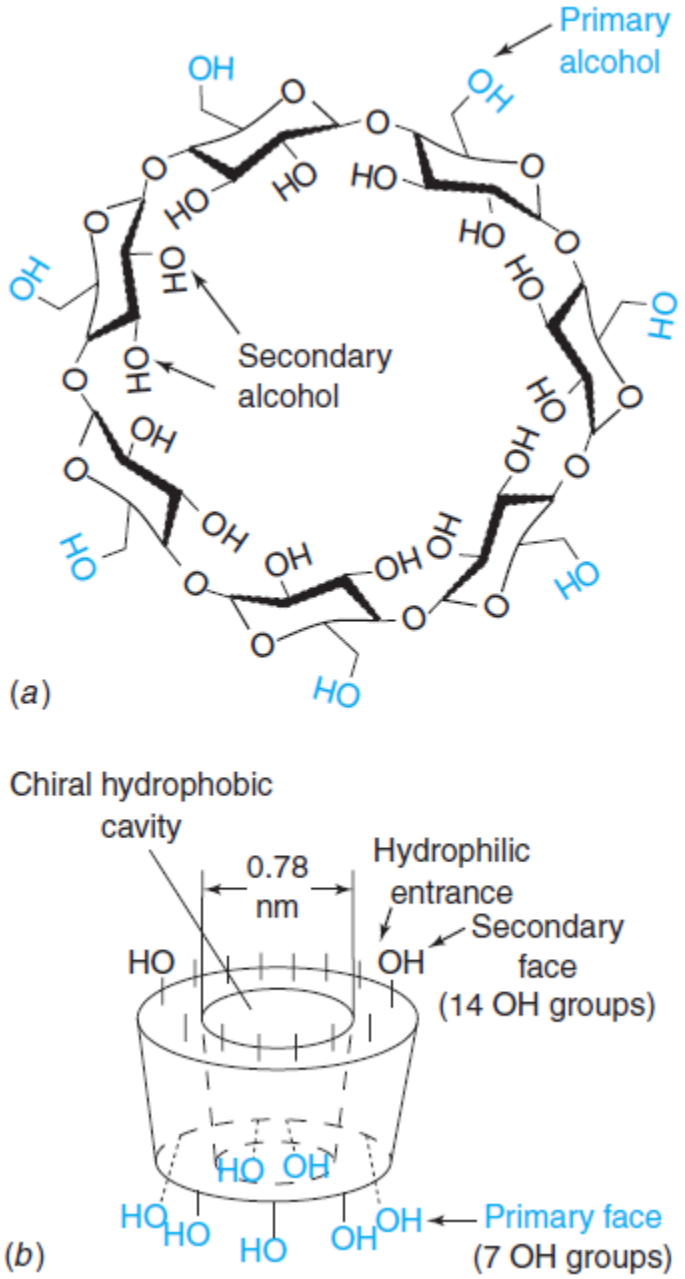
An interesting aside

- The ratio of diphenyl and dimethyl groups changes polarity
- Also changes the temperature range
  - Important to prevent stationary phase “bleed”

Structure	Polarity		Temperature range (°C)
 (Diphenyl)$_x$(dimethyl)$_{1-x}$	$x = 0$	Nonpolar	−60°–320°
	$x = 0.05$	Nonpolar	−60°–320°
	$x = 0.35$	Intermediate polarity	0°–300°
	$x = 0.65$	Intermediate polarity	50°–370°

Chirality of Stationary Phase

- Chiral stationary phases have an effect on chiral analytes
- Cyclodextrins (a) are bonded to polysyloxane groups
- Enantiomers have different interactions through center of ring
  - Causes separation of enantiomers



References

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3. Gas Chromatography https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Instrumental_Analysis/Chromatography/Gas_Chromatography (accessed Dec 4, 2020).
4. Harris, D. C. *Quantitative Chemical Analysis*, 8th ed.; W.H. Freeman and Co: New York, 2010. Chapter 23.