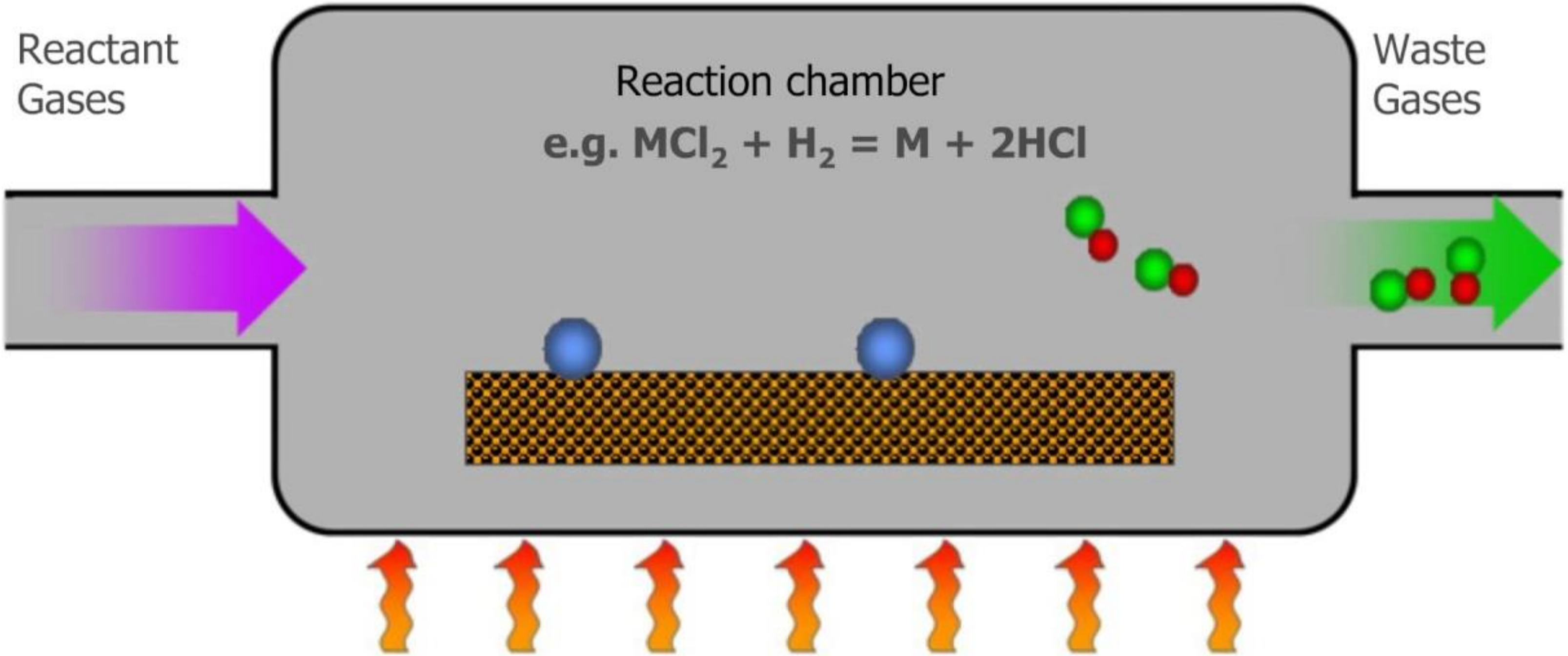
Chemical Vapor Deposition (CVD)

- Chemical vapour deposition or CVD is a process whereby a solid material is deposited from a vapor by a chemical reaction occurring on or in the vicinity of a normally heated substrate surface.
- The solid material is obtained as a coating, a powder, or as single crystal
- By varying the experimental conditions such as
  - substrate material
  - substrate temperature
  - composition of the reaction gas mixture
  - total pressure gas flows, etc.

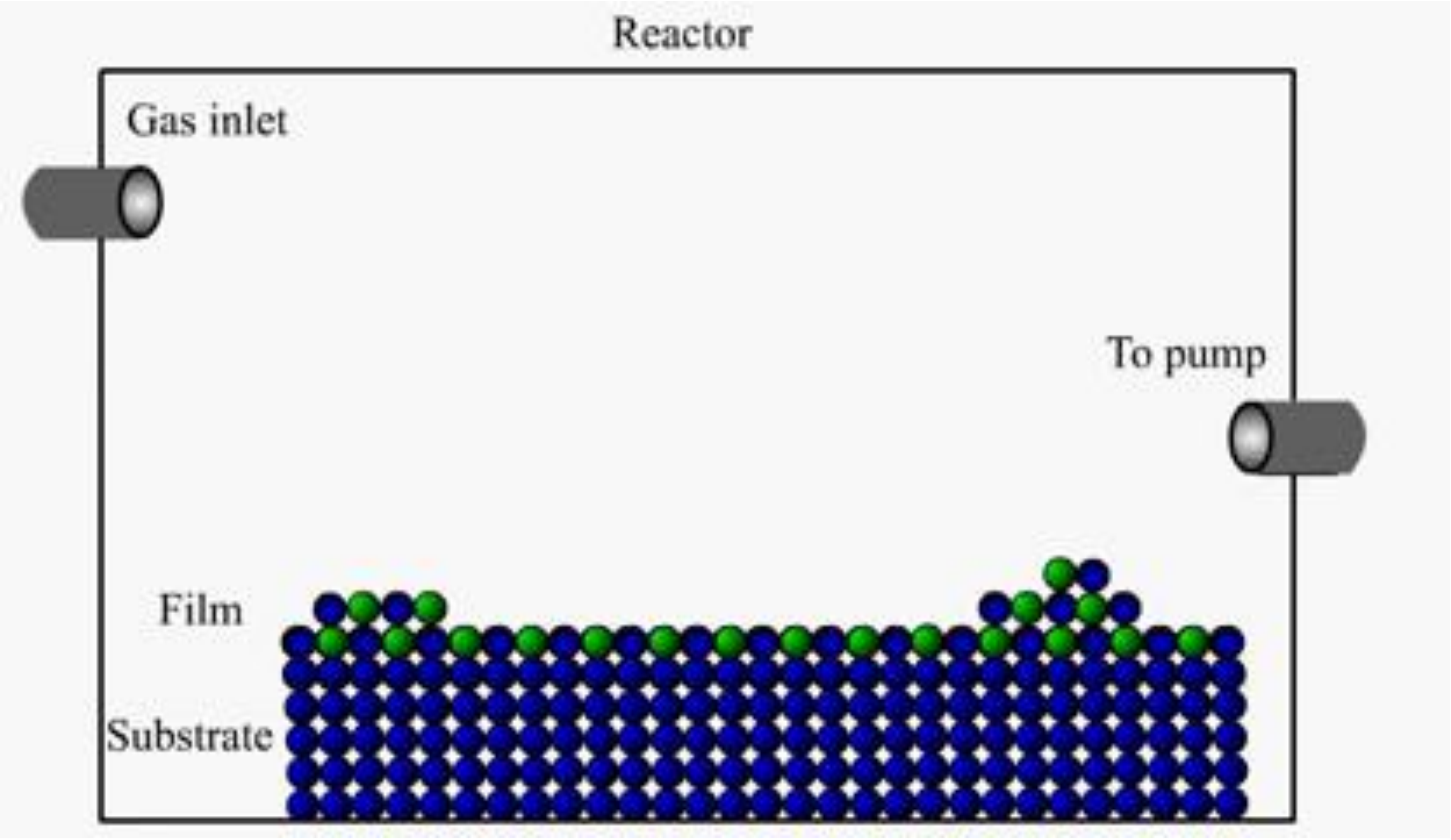
  materials with different properties can be grown
- CVD is an example for solid-vapor reaction

Chemical Vapor Deposition (CVD)

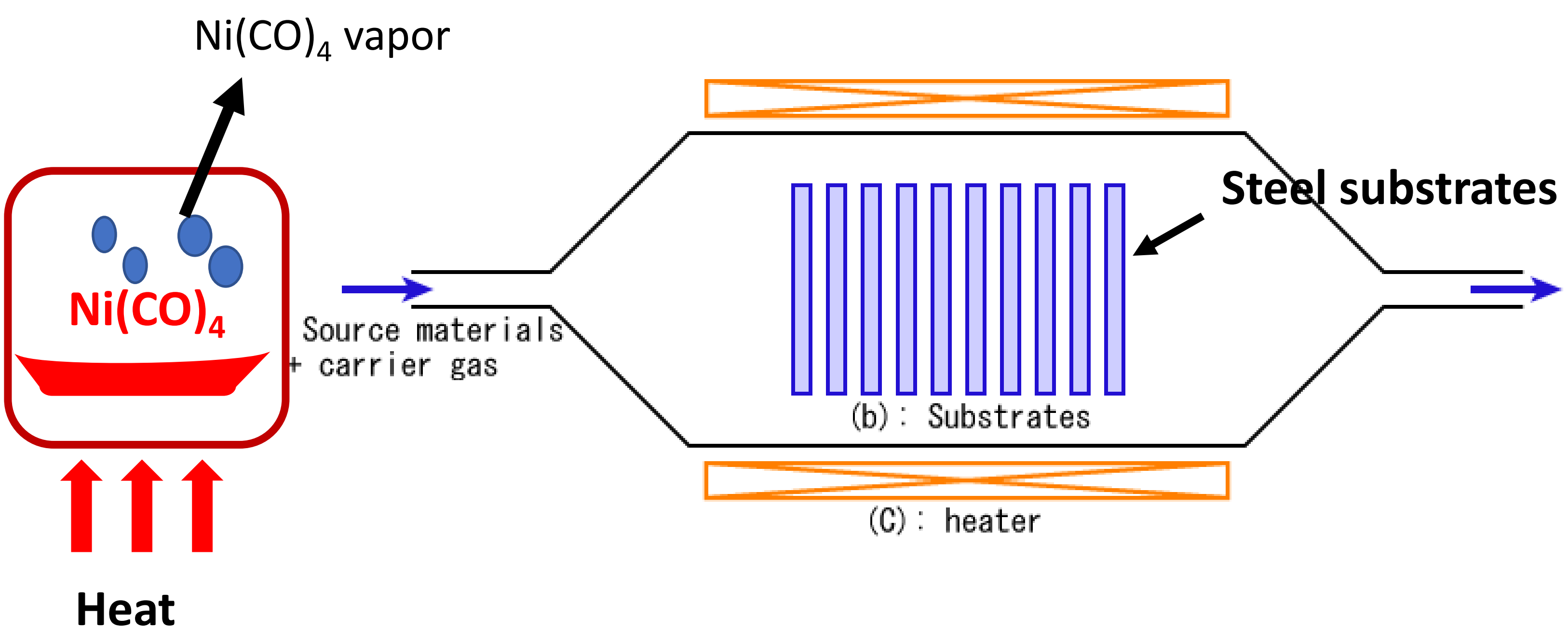
"CVD is a process where gaseous precursors react to form a solid coating on a heated substrate"



Chemical Vapor Deposition (CVD)



Nickel Coating on top of Steel



Nickel Carbonyl vapor decomposes on top of heated steel substrate to form nickel coating and gaseous by-products

Optimized Temperature and flow rate

Chemical Vapor Deposition (CVD)

CVD Apparatus

A CVD apparatus consist of several basic components

➢	**Gas delivery system**	–	For the supply of precursors to the reactor chamber
➢	**Reactor chamber**	–	Chamber within which deposition takes place
➢	**Substrate loading mechanism**	–	A system for introducing and removing substrates, mandrels etc.
➢	**Energy source**	–	Provide the energy/heat that is required to get the precursors to react/decompose.
➢	**Vacuum system**	–	A system for removal of all other gaseous species other than those required for the reaction/deposition.

Chemical Vapor Deposition (CVD)

➢	**Exhaust system**	–	System for removal of volatile by-products from the reaction chamber.
➢	**Exhaust treatment systems**	–	In some instances, exhaust gases may not be suitable for release into the atmosphere and may require treatment or conversion to safe/harmless compounds.
➢	***Process control equipment***	–	Gauges, controls etc to monitor process parameters such as pressure, temperature and time. Alarms and safety devices would also be included in this category

This coating finds application on glass containers to make explosion or shatter resistant glasses.

Advantages of CVD over PVD

- ✓ **CVD films are generally quite conformal,** i.e. the ability of a film to uniformly coat a topographically complex substrate
- ✓ **Versatile –** any element or compound can be deposited
- ✓ **High purity** can be obtained
- ✓ **High density –** nearly 100% of theoretical value
- ✓ **CVD films are harder** than similar materials produced using conventional ceramic fabrication process
- ✓ **Material formation well below the melting point**
- ✓ **Economical in production,** since many parts can be coated at the time

Disadvantages of CVD

- Need to have precursors – volatile near room temperature.
- Most of the precursors are toxic or corrosive.
- Some precursors are very costly.
- Deposition at elevated temperatures has restrictions on substrates used.
- All surfaces in the reaction chamber get coated.
- Separate process and reaction must be developed for each coating.
- Some of the gases are toxic and dangerous.

CVD applications

- **Coatings** – Coatings for a variety of applications such as wear resistance, corrosion resistance, high temperature protection
- **Semiconductors and related devices** – Integrated circuits, sensors and optoelectronic devices
- **Fiber optics** – for telecommunication
- **Used in the microelectronics industry** to make films serving as dielectrics, conductors, passivation layers, oxidation batteries and epitaxial layers

PVD *vs* CVD

PVD	-	CVD
Low temperature process (500 °C)	-	High temperature process (1000 °C)
Thin coatings	-	Thick and thin coatings
Non-uniform coatings	-	Uniform coatings
Sharp cutting edges possible	-	Larger honing radius needed
Tough cutting edges	-	Wear resistant coatings