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Contamination Control, Cleaning and Surface Preparation for Vacuum Applications – An Introduction

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Programme

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Mark Dugan, Acota Ltd, Shrewsbury.

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11:15 - coffee break

11:30 **RGA's for Vacuum Diagnostics and Outgassing Measurements**
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11:50 **Case Study** - Stephen Fletcher, X-Tek Systems Ltd, Nikon.

12:10 **Vacuum Cleanliness in the Semiconductor Industry**
Alan Web, Consultant

12:30 **Vacuum Support, whatever that might be?**
Tom Weston, Daresbury Laboratory.

Draw attention to meeting flyer introduction…

In vacuum systems, to ensure effective operation and success of the contained process, it is usually necessary to adopt rigorous contamination control and/or cleaning techniques.

This is often more important than the selection of the vacuum equipment that is required to achieve the operational vacuum levels, yet it is often the least considered aspect of a vacuum system design.

Cleaning, Processing, Conditioning *– Essential for many applications that require vacuum.*

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Why Do We Need To Clean or Control Contamination in Vacuum?

It Depends on What We Need Vacuum For,

- Vacuum Regime Required (Type of Flow)
- Ultimate Pressure
- Leak Rate
- Cleanliness (contaminant free)

$\therefore$ **"To Clean or Not To Clean"** &

"Degree of Cleanliness or Surface Preparation"

$\Rightarrow$ **Depends upon Application!**

$\Rightarrow$ **Might not even be necessary!**

Examples

- Irrespective of application - Manufacturer Desires Attractive **Appearance**!
- Characteristics of a Surface (Surface Properties) altered by **'Contamination' at the Surface**.
- **Process Poisoned** by 'Contaminants'
- Quality of an In-Vacuum Process Severely Affected By Presence of **'Contaminant' Gas Phase Molecules**

! **'Contaminant'** - What is a contaminant in one application may be an essential constituent of another!

Why Control Contaminants for - Accelerator Vacuum Systems

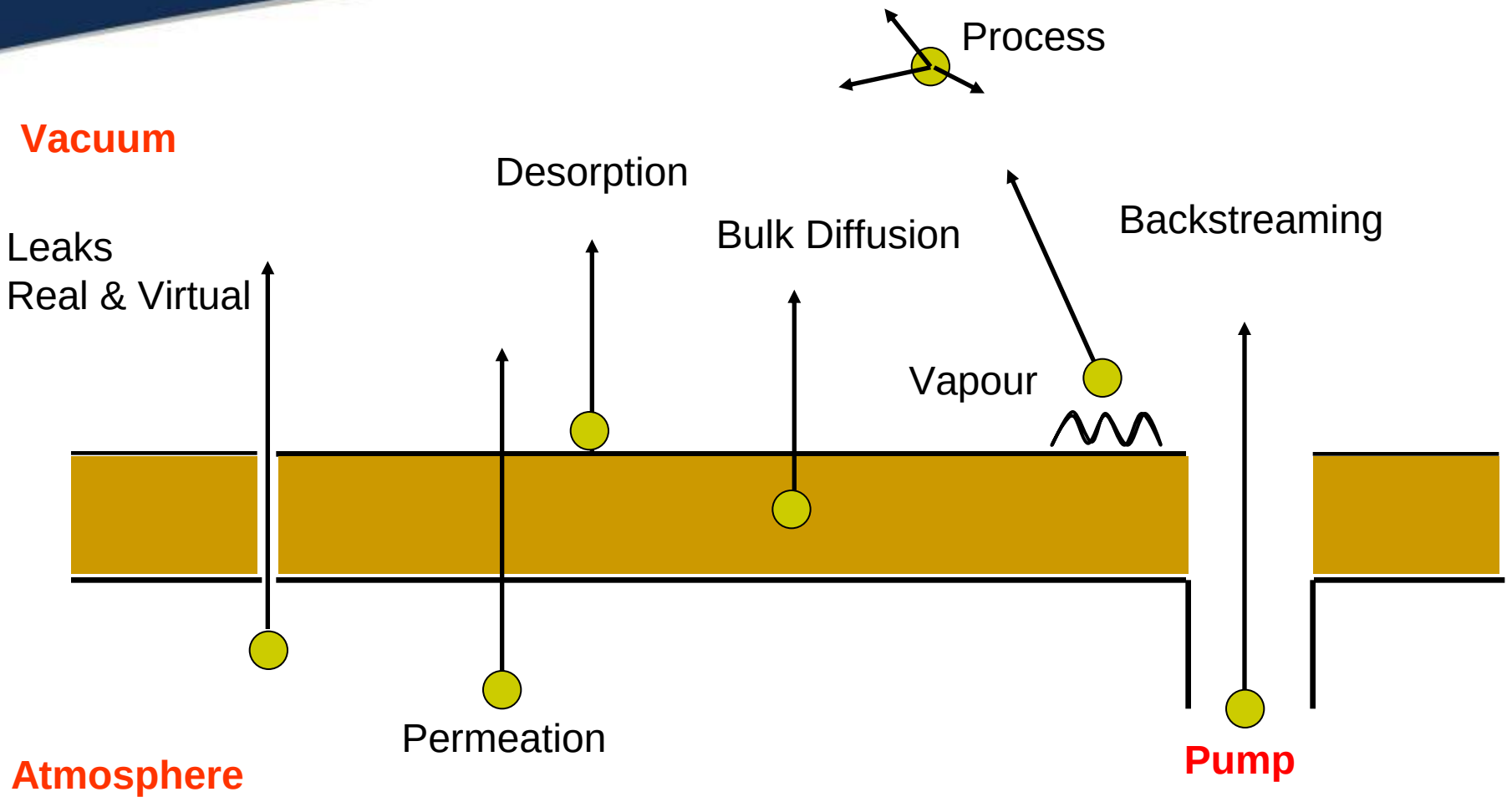
Transport of Particles and EM Radiation Loss Reduction

Reduce Scattered Radiation for **Health Reasons**
(exposure limits)

Maintain **Clean In-Vacuum Surfaces**

- Prevent Particle Target Poisoning
- Maintain Efficient Optical Properties for EM Radiation Transport
- To reduce ion production.

To Provide a **Controlled Atmosphere** for experiments



To Reduce Potential Contaminants, we must Inhibit or Reduce the source of the problem. Hence, need to understand the source of contamination.

Controlling Contamination

- Cleaning – removing contaminants
- Passivation – reducing the effect of contaminants.
- Depletion of gas sources – bulk diffusion, trapped volumes (perhaps by bakeout or firing)
- Quality of process gas/materials
- Barriers – Prevent contaminants entering vacuum system (thin films, oxide layers)
- Good Vacuum Technique – Prevent contaminants entering vacuum system during Design, Procurement and System-Build/Commission.

Take as an example- CLEANING - Broad Range of Methods Available (Topic is Broad and Complicated)

Chemical	Thermal Treatment	Polishing	In-Situ Treatment	Others…
Wash – Detergent or Solvent	Vacuum **Bakeout**	**Electro-Polish**	Vacuum **Bakeout**	**Bead Blasting**
Ultrasonic – Aqueous or Solvent	**Vacuum Fire** (typical ~950C for STST)	**Diamond Paste** Machine/Manual	**UV Lamps**	**CO2 Snow**
Vapour Clean– Solvent	**Air Bake** (up to ~ 400C)	**Plasma Etch**	**Glow Discharge**	
ACID Etch – Pickling or Passivation	**Vacuum Remelt**	**Diamond Turning**	**Chemical**	
Power Wash – Water Jet		**BCP-Buffered Chemical Polishing**	**Plasma**	

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Some examples of types of cleaning agents:-

- Cleaning Agents
  - Water based
  - Solvent based
    - Alcohols
    - Chlorinated hydrocarbons
    - (Freons)
    - Hydrofluoroether
    - Non flammable ethers
- Detergents
  - Aqueous
  - Alkaline degreasers

Etchants

- Acids
- Alkalis

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Measuring Cleanliness

- Phenomenologically
  - Measure outgassing (thermal desorption)
  - Measure stimulated desorption (according to requirements of system)
  - In each case total and partial pressure measurements useful

- Characterise surfaces
  - Surface analysis

- Through ‘Process’ Results or System Performance

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