PROCESS ANALYTICAL TECHNOLOGY (PAT)

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PROCESS ANALYTICAL TECHNOLOGY

WHAT IS PAT?

FDA's vision:

A system for **designing**, **analyzing**, and **controlling** manufacturing through **timely** measurements (during processing) of critical quality and performance attributes of raw, and in-process materials and processes with the goal of ensuring final product quality for a significant number of **products on the market** or **in development**

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WHAT IS PAT?

Any *in-situ* measurement that participate in control or gathering data for understanding of the process;

E.g. FTIR, Raman, ATR-UV, NIR probes, MS, HPLC, FBRM, PVM, NMR;

PAT probe can measure either chemical or physical aspects (flow, temperature, pressure, pH value);

PAT role in development is process understanding;
PAT role in manufacturing is a control strategy tool;

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WHY USE PAT?

- The use of PAT can improve R&D efficiency and minimize personnel hazard;
- Speeds up processes → sampling, analyses
- Reliable, rapid analyses of a process
- Significant data for developing process chemistry understanding (detection of reaction intermediates, mechanisms, relationship between process variables);
- Reduction of the number of critical parameters;
- Results in set of controls (off-line or in-line);
- Fully supported by authorities;
- More frequent data collection;
- Automated measurement;
- Real time process control;
- Eliminates difficult and hazardous sampling

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WHEN TO USE PAT?

Depends on many factors throughout the product life cycle:

- Development
- Manufacturing (e.g. heterogeneous reaction sampling)
- Troubleshooting
- Capacity of PAT tools
- Sensitivity of a PAT tool

Especially useful during **continuous** processes

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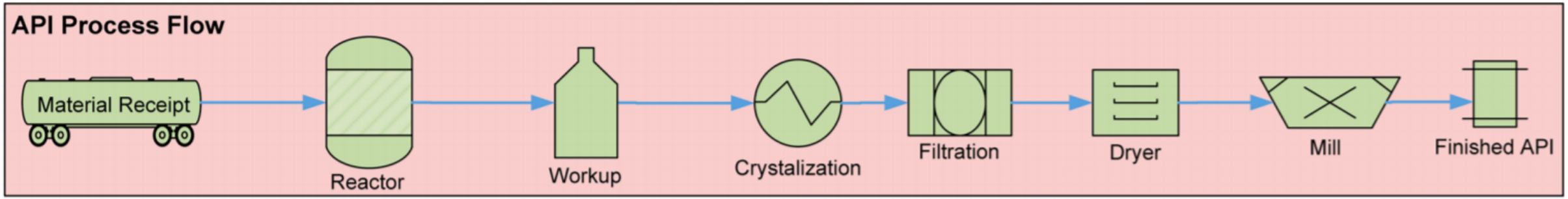
WHEN TO USE PAT?



Material Receipt	Reactor	Workup	Crystalization	Filtration	Dryer	Mill	Finished API
Analysis Needs: Identification Typical Techniques: **In Field:** MIR, NIR, Raman (Hand Held) **In Lab:** MIR, Chromatography	Analysis Needs: Reaction completion, impurity profile, kinetics, solvent composition Typical Techniques: Calorimetry, Chromatography MIR, NIR, UV, Raman, NMR, Polarimetry pH, Temperature, Pressure	Analysis Needs: Reaction yield, impurity profile, solvent composition Typical Techniques: Chromatography, MIR, NIR	Analysis Needs: Particle distribution, shape, form, supersaturation Typical Techniques: Turbidity, FBRM, PVM, Raman, MIR		Analysis Needs: Moisture/solvent content, form, particle attrition/ agglomeration Typical Techniques: FAIMS, MIR, NIR, MS (Exhaust), NIR (direct), Raman, FBRM	Analysis Needs: Particle size Typical Techniques: FBRM	Analysis Needs: Identification Typical Techniques: MIR, NIR, Raman

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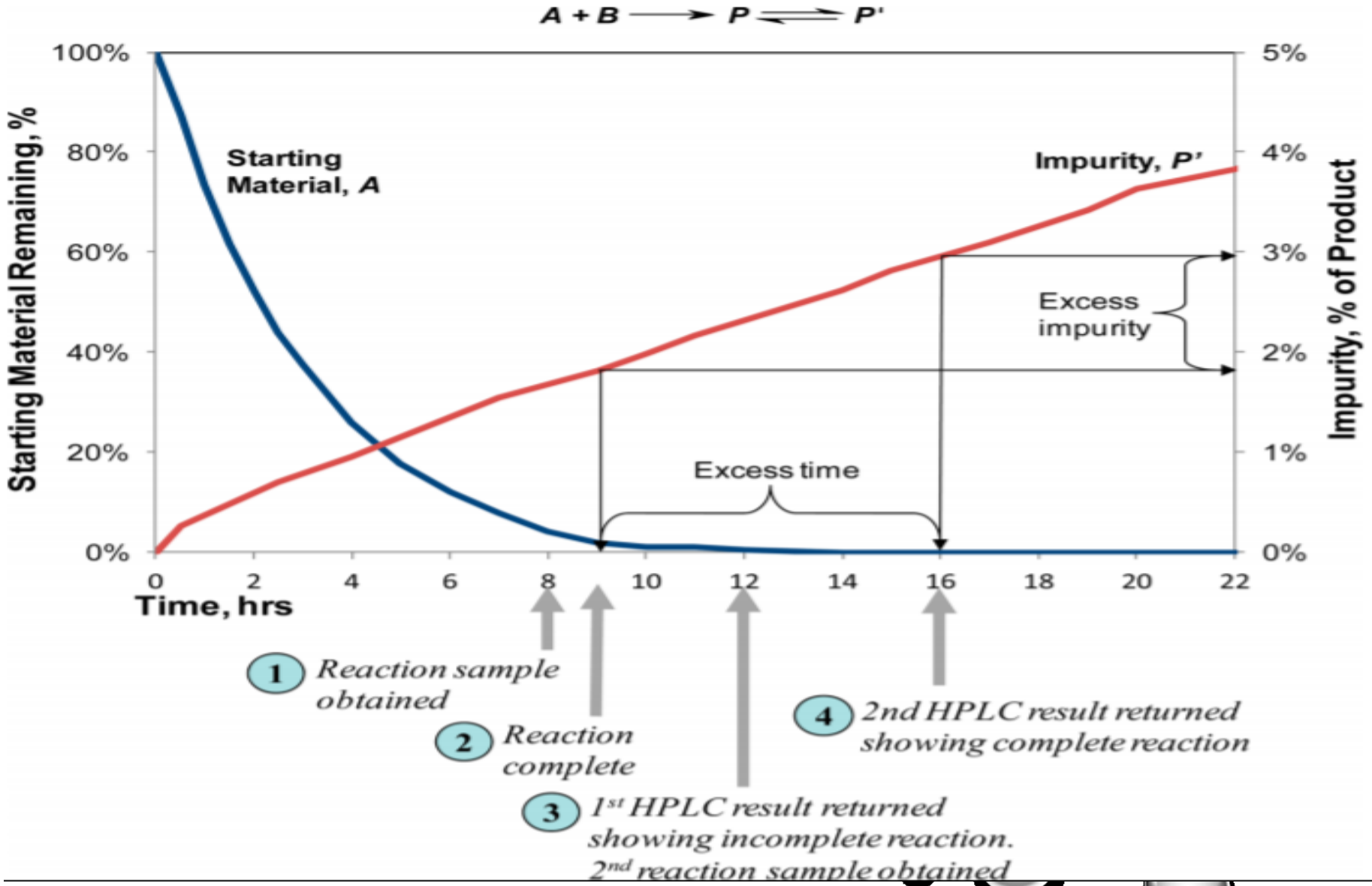

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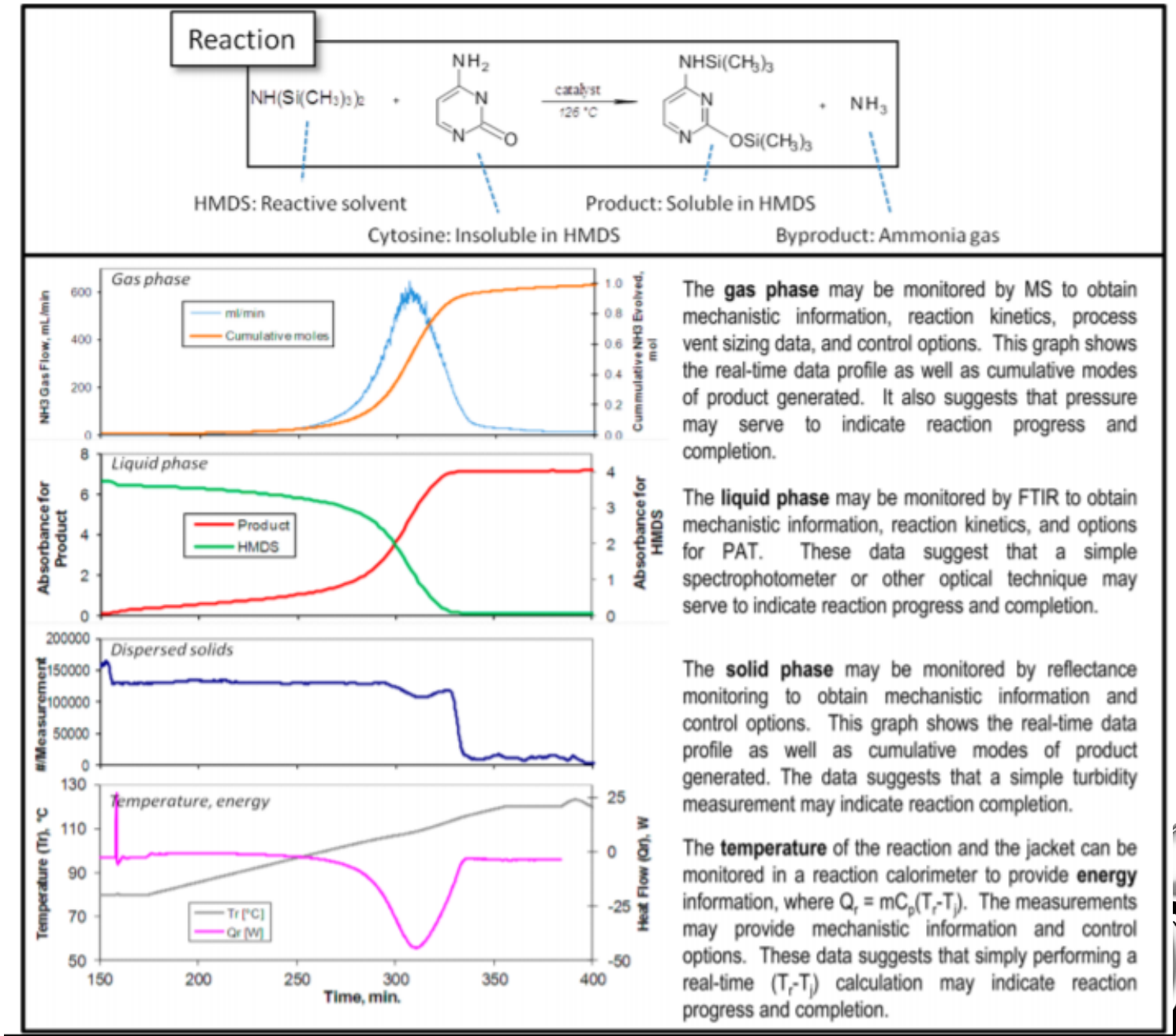
Chanda, A. *et al* *Org.Process Res.Dev. 19*, 63 (**2015**)



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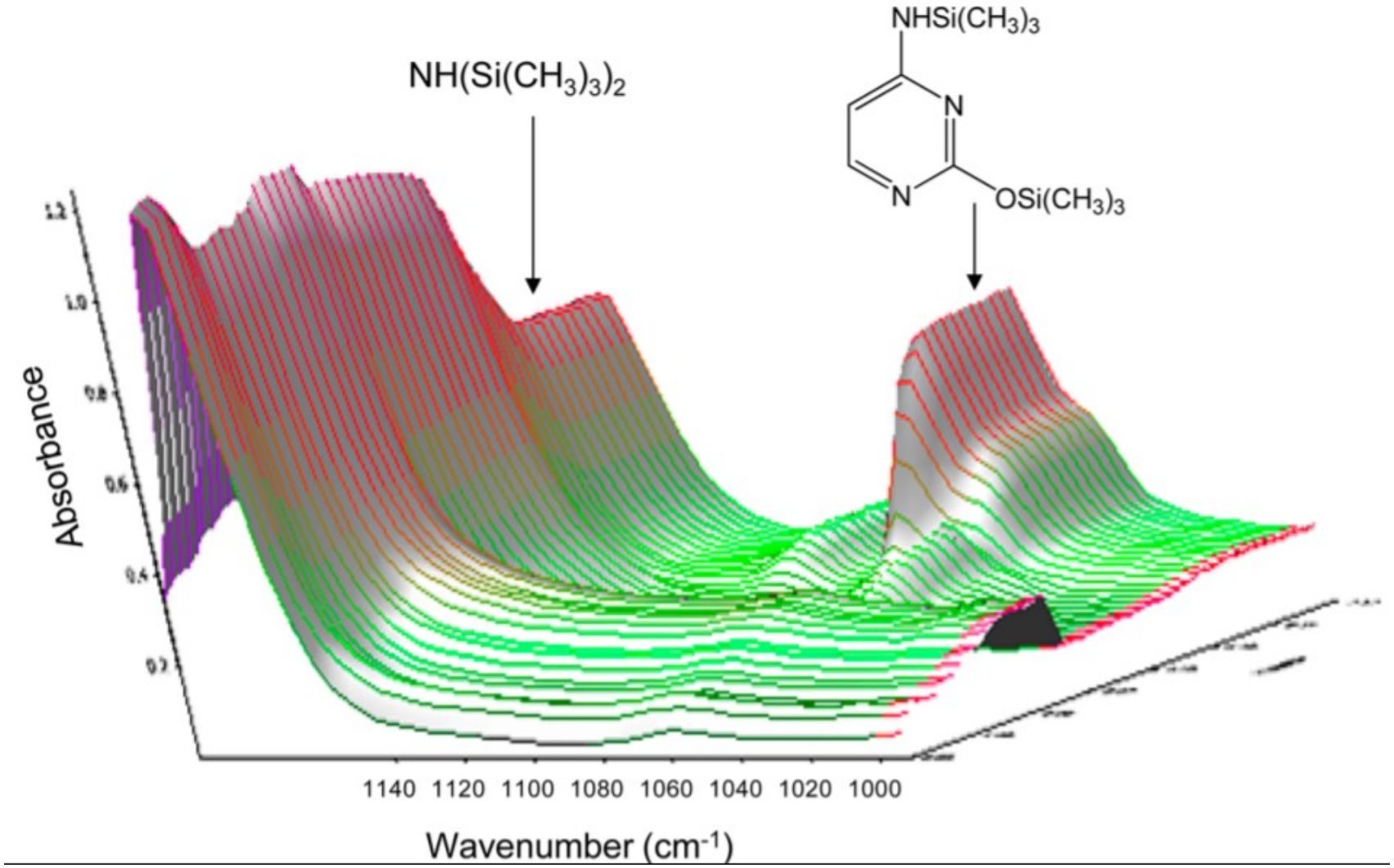

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