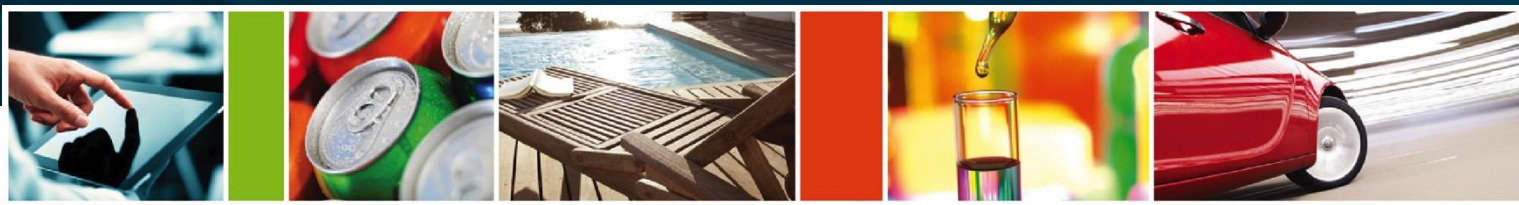
Curing Chemistry of Organic Coating Systems



www.allnex.com

Dr. Patrice Roose

ANALYTICAL DROGENBOS: MATERIALS CHARACTERIZATION

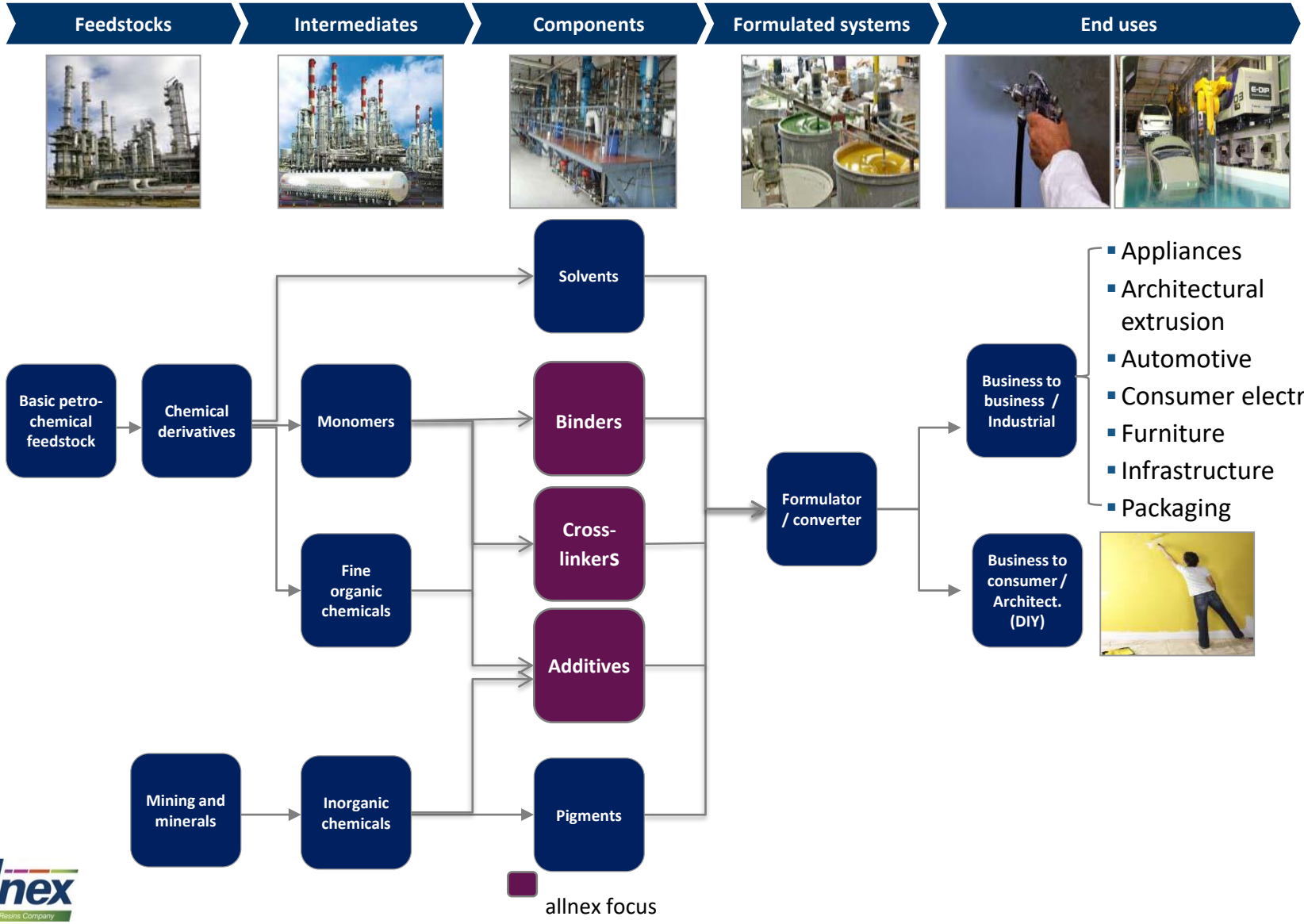
Patrice Roose

PhD Physics, Vrije Universiteit Brussel, 1997

- 1989: Academic assistant, Dept. Applied Physics and Physics, VUB
- 1998: IWT post-doc fellow
- 1998: UCB-Chemicals
- 2005: Cytec
- 2013: allnex

- Senior scientist and head of materials characterization lab
  Analytical research group, allnex Belgium SA/NV, Drogenbos
- 25+ peer reviewed papers
- 5 patents

RESINS ARE PART OF COATING SYSTEMS



Overview

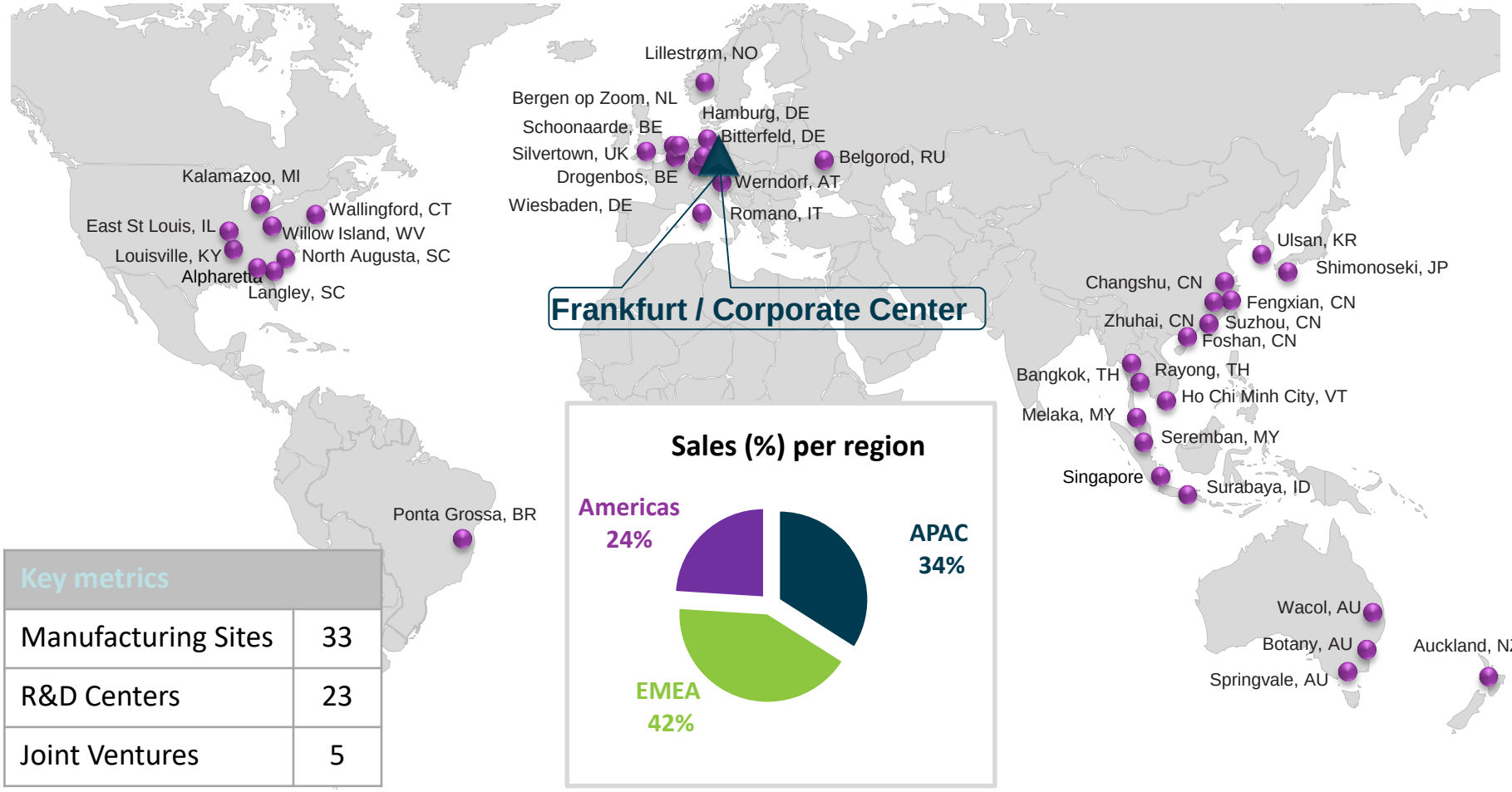
allnex is a leading producer of resins, additives and crosslinkers for use in various industrial coating resins applications

	LIQUID RESINS & ADDITIVES	PERFORMANCE RESINS		
		RADIATION CURABLE RESINS	CROSSLINKERS	POWDER COATING RESINS
Key Technologies	▪ **Waterborne** *PUD, Alkyds, Epoxies, Acrylics CED Resins* ▪ **Solventborne** *Alkyds, Acrylics, Polyester, SCA* ▪ **Coating Additives** ▪ **Urethane Specialties**	▪ **Oligomers** *Urethane Acrylates, Epoxy Acrylates, Polyester Acrylates, Amino Acrylates, UV-PUD* ▪ **Monomers** ▪ **UVEKOL® Glass Lamination** ▪ **VANCRYL® Acrylics**	▪ **Amino Crosslinkers** ▪ **Formaldehyde-free Crosslinkers** ▪ **Phenolic Coating Resins** ▪ **Technical Phenolics**	▪ **Polyester Resins** ▪ **Hybrid, Standard Durable Super Durable UV Powder Resins** ▪ **Additives**
Key Segments	▪ Automotive and refinish ▪ Industrial Wood ▪ Protective & General Metal ▪ Architectural ▪ Plastic	▪ Inks & Overprint Varnishes ▪ Industrial Wood ▪ Electronics ▪ Plastic	▪ Industrial Wood ▪ Metal Packaging ▪ Automotive ▪ Tires & Rubber Product	▪ Architectural Extrusions ▪ Domestic Appliances ▪ General Metal
% of Revenue	56%	15%	15%	14%

Global player with €2.1 billion annual sales and a leading product portfolio

Global

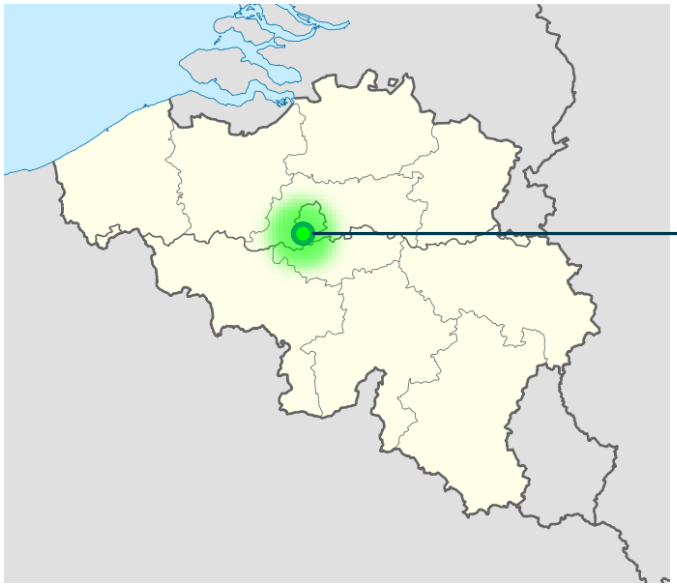
Following the merger with Nuplex, allnex has 33 manufacturing sites across the world. allnex now has its Corporate Center in Frankfurt.



Key metrics	
Manufacturing Sites	33
R&D Centers	23
Joint Ventures	5

The operating allnex group is legally owned by Allnex Holdings S.à r.l., a company based in Luxembourg, which also provides long term strategic decisions relating to its investment in allnex.

ALLNEX BELGIUM SA/NV
DROGENBOS SITE

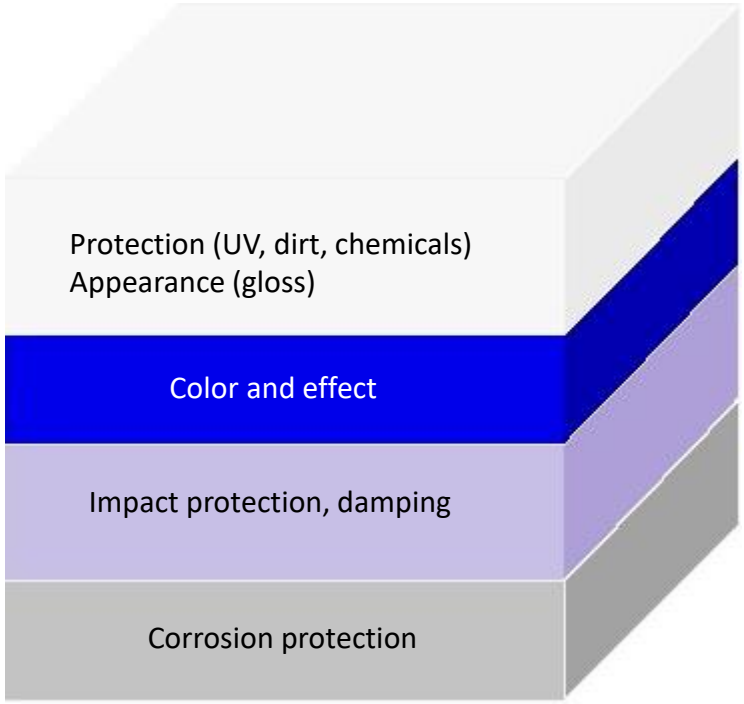


ucb Chemicals → 2003 → Surface Specialties ucb → 2005 → CYTEC Surface Specialties → 2013 → Allnex → 2016 → allnex The Coating Resins Company

allnex The Coating Resins Company

INTRODUCTION

Example: Automotive OEM car paint layers



Clearcoat: 30-50 µm

Basecoat: 10-20 µm

Primer: 30-35 µm

E-coat: 20 µm

WHY COATINGS?

- Protection
- Decoration

- Durable properties (hardness, mechanical and chemical resistance → no or slow dynamics, permanent crosslinks)

  ↕

- Dissipative properties (flexibility, adhesion, damping, healing → dynamic network segments)

Film Formation

- From a solution
  - Resins in organic solvent
  - Resins in reactive solvent
  - Resins in water
- From a dispersion
  - Aqueous
  - Non-aqueous
- From a powder

CURING

- Chemical: Chemical conversion of reactive moieties leading to a significant change in physical properties. Usually a non-linear reaction process.
- Physical: Formation of insoluble film from a liquid (resin).
- Practical: buildup of solid coating property (elasticity, hardness, solvent resistance, tack, barrier properties, …).
- Other definitions can be found in the literature.

PHYSICAL *VS.* CHEMICAL DRYING

- Physical drying
  - Removal of solvent is required
  - Polymer is solid (high T_g) after solvent evaporation
  - Basically thermoplast

- Chemical drying (curing)
  - Solvent is not always required
  - Drying results from chemical reaction
  - T_g build-up during polymerization, solid and insoluble after curing
  - Thermoset

BINDER *VS.* CROSSLINKER

- Binder
  - Often bifunctional
  - Primary constituent
- Crosslinker/hardener
  - Polyfunctional
  - Additional constituent

CURING CONDITIONS

- Thermal
  - Ambient (typ. 2K)
  - Force drying (hot air up to 80°C)
  - Stoving or baking (> 100°C)
- Radiation
  - Ultraviolet
  - Electron-beam
- Combined-Dual