Advancements in Field Joint Coatings for Onshore and Subsea Pipelines

SOMAIEH SALEHPOUR, PhD
General Manager, Canusa-CPS

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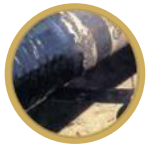
Advancements of Field-Joint Coatings Technologies

Coatings Evolution

1930's	1950's	1960's	1970's	1980's	1990's	2000's
						
MLC: Coal Tar	**MLC:** Cold Applied Tapes	**MLC:** Yellow Jacket, **FJC:** Mastics HSS	**MLC:**FBE **FJC:** Liquid Epoxies	**MLC:** 3LPO **FJC:** Hotmelt HSS	**MLC:** HPPC **FJC:** Hybrid HSS	**MLC:** 3L PP, Visco-elastics, **FJC:** Factory Grades, Automation

Current Trends:

- **High performance coatings**
- **Smart and connected systems**
- **End-to-End solutions**

Advancements of Field-Joint Coatings Technologies

Corrosion and Coating Selection

Iron containing metal (steel pipes) + Oxygen + Electrolyte (water)

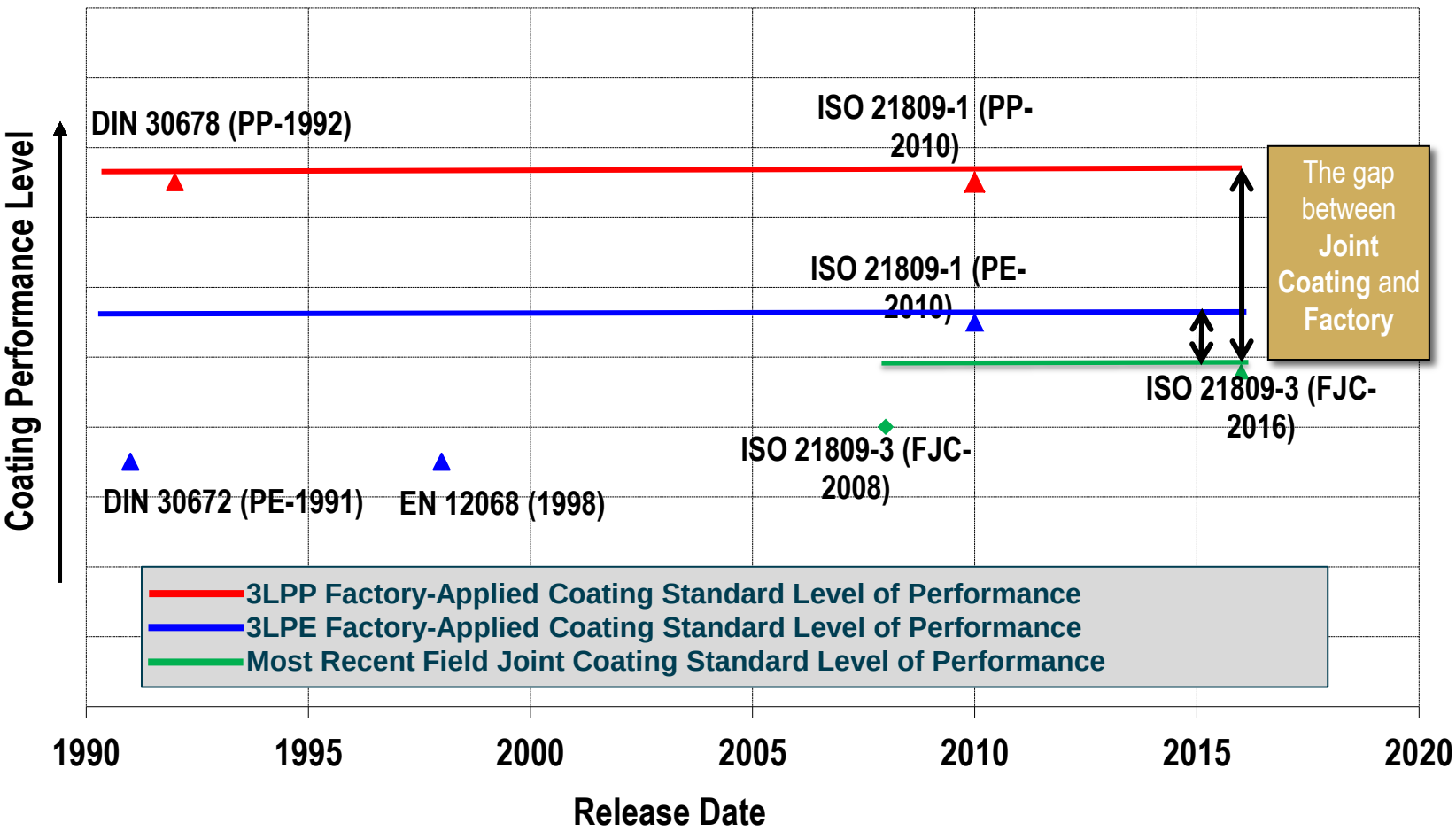
CORROSION!

- **All good coatings on the market should prevent water and oxygen ingress**
- **Selection should be based on design criteria which are influenced by standards**

One size does NOT fit all!

Advancements of Field-Joint Coatings Standards

The Gap between FJ coating and ML coating properties



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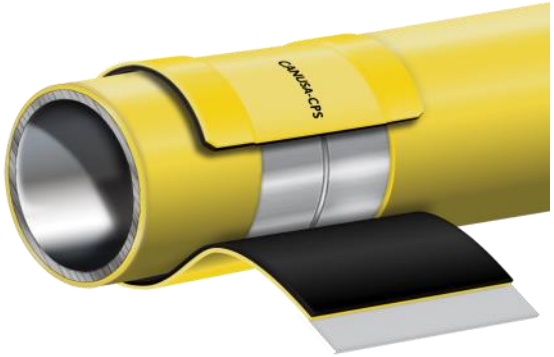
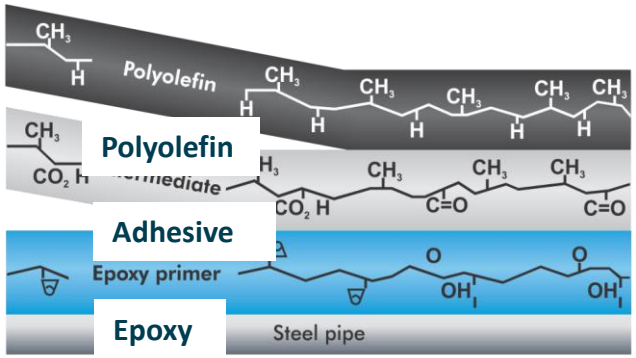
Advancements in Chemistry of Coatings

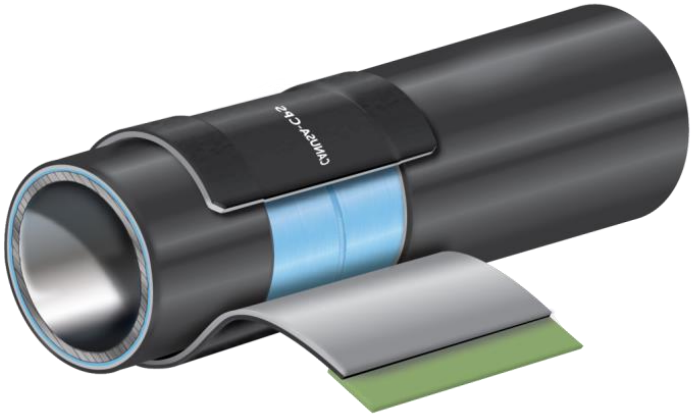
2-layer or 3 layer systems

Mechanisms of adhesion:

1. Physical Absorption
2. Mechanical Interlocking
3. Electrostatic
4. Diffusion
5. Chemical Bonding



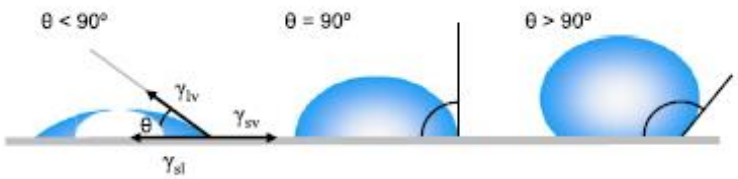




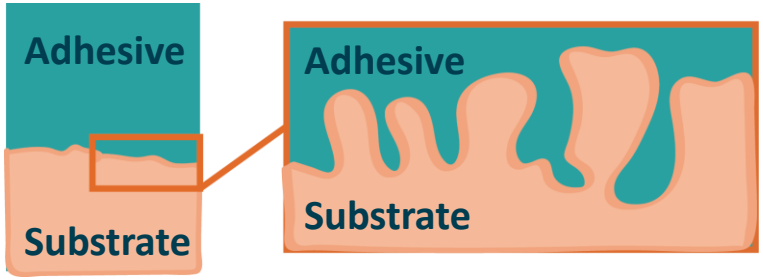
Advancements in Chemistry of Coatings

Mechanisms of Adhesion

1. **Physical Absorption:**
Secondary or **Van der Waals** forces

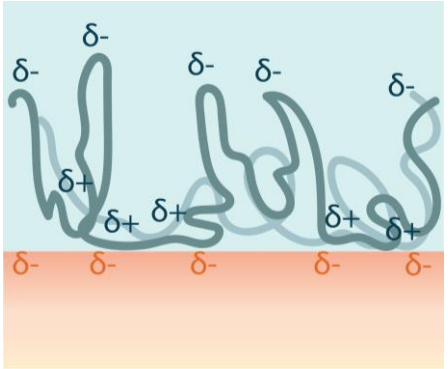


2. **Mechanical Interlocking:**



3. **Electrostatic interactions:**

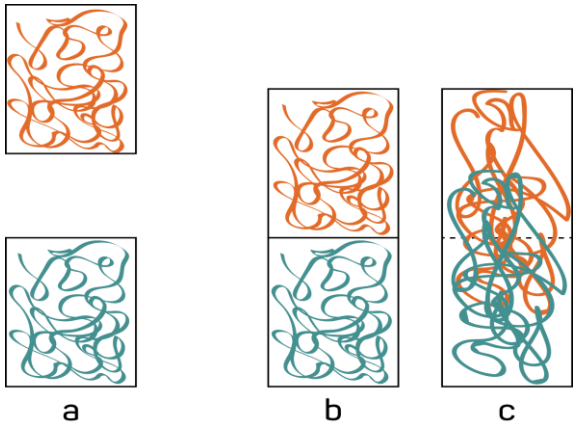
Based on difference in electronegativities of the materials



Advancements in Chemistry of Coatings

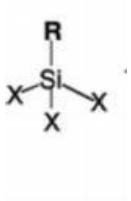
Mechanisms of adhesion

4. **Diffusion of Polymers:**

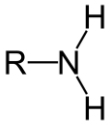


5. **Chemical Bonding:**

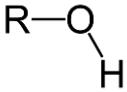
Formation of **covalent**, **ionic** or **hydrogen bonds** across the interface.



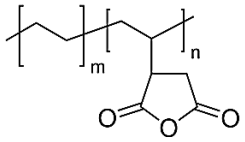
Adhesion Promoters



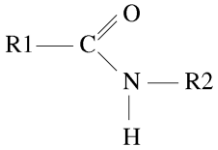
Amines



Hydroxyls



Maleic Anhydride

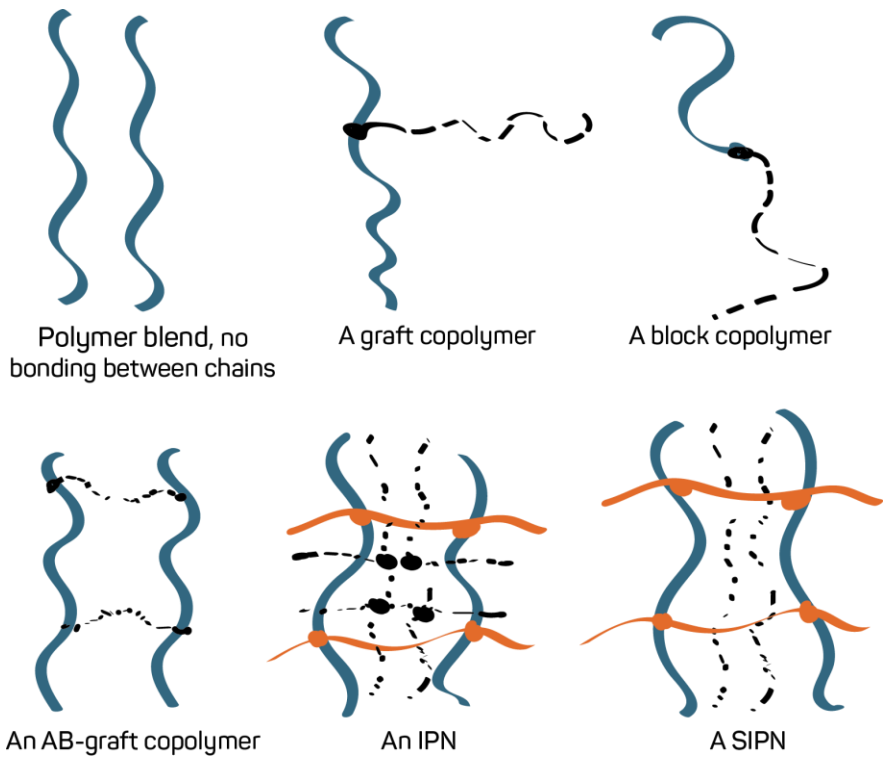


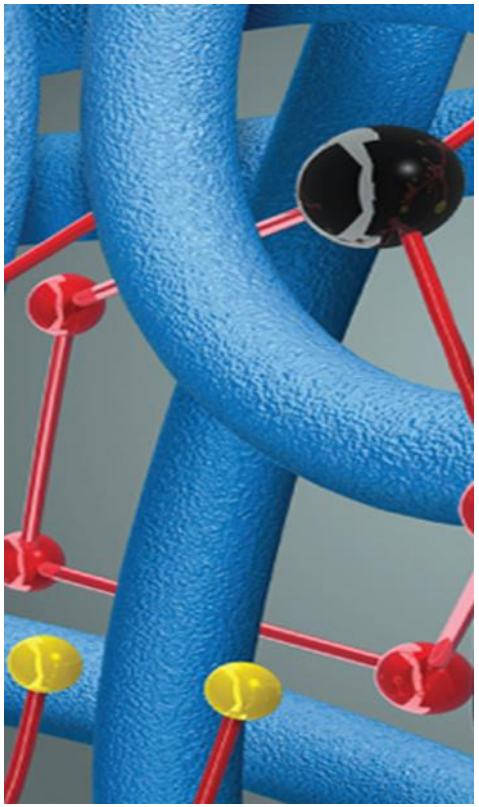
Amides

Advancements in Chemistry of Coatings

Interpenetrating Polymer Network (IPN) Hot Melt Systems

Formation of Strong **Covalent bonds** for robust FJC





Advancements: Smart, Connected Solutions

Definition

“Smart, connected solutions are products, assets and other things embedded with processors, sensors, software and connectivity that allow data to be exchanged between the product and its environment, manufacturer, operator/user, and other products and systems.”

Physical components = discrete mechanical, chemical and/or electrical parts

Smart components = sensors, microprocessors, data storage, controls, software, embedded operating system and user interface

Connectivity components = ports, antennae, and protocols enabling wired or wireless connections (one-to-one, one-to-many, many-to-many) inside and outside the physical device – in the cloud.

What Can Smart, Connected Solutions Do?

Capabilities

Monitoring

1. Sensors & External Data

- product conditions
- external environment
- product operation and usage
- notification of changes

Control

2. Embedded software in product or cloud

- control of product functions
- personalization of user interface & user experience

Optimization

3. Algorithms to optimize operation

- enhance product performance
- allow predictive diagnostics, service and repair

Autonomy

4. Combining monitoring, control, optimization

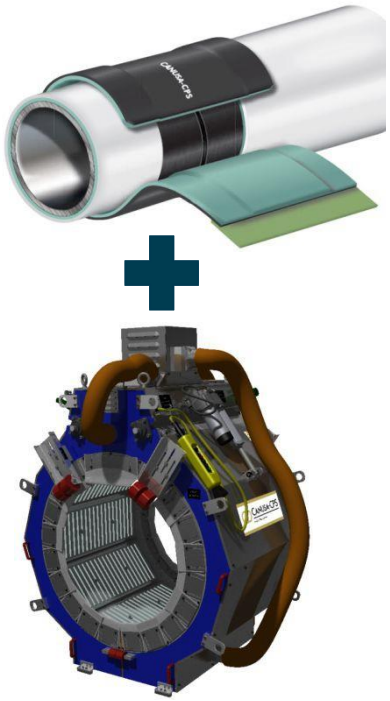
- autonomous operation
- self-coordination of operation with other products & systems
- autonomous enhancement
- self-diagnosis and service

Porter, M., Heppelmann J. Harvard Business Review. November 2014.

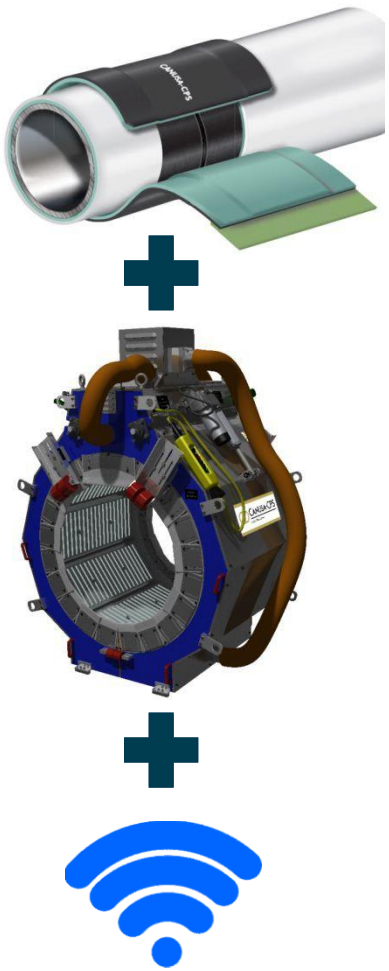
Smart, Connected Coating Solutions

1. Coating Application Application

2. Smart Application



3. Smart, Connected



Example:
Heat Shrinkable Polyolefin Coating Systems

Smart, Connected Coating Solutions

Video: Heat Shrinks Sleeves application and data collection with IntelliCOAT

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Smart, Connected Solutions for High Performance Field Joint Coatings

Technology Stack

Identity and Security
- Login Authentication

External Information Sources
- GPS
- Weather

Integration with Business Systems
- ERP
- CRM

Cloud

Software Applications
Analytics Engine
Application Platform
Real time database

Connectivity

Network Communication
Direct/Manual

Product/Equipment

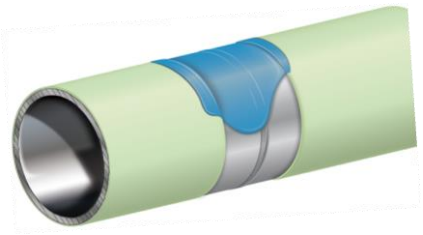
Software
Hardware

External Client Access
- Daily notifications
- Generate reports

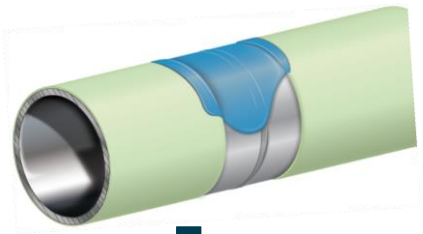
Internal Administration
- User management
- Project management
- Data report approval
- QC cert database management
- Query machine history

Smart, Connected Coating Solutions

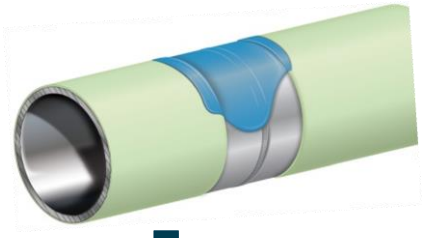
1. Coating Application



2. Smart Application



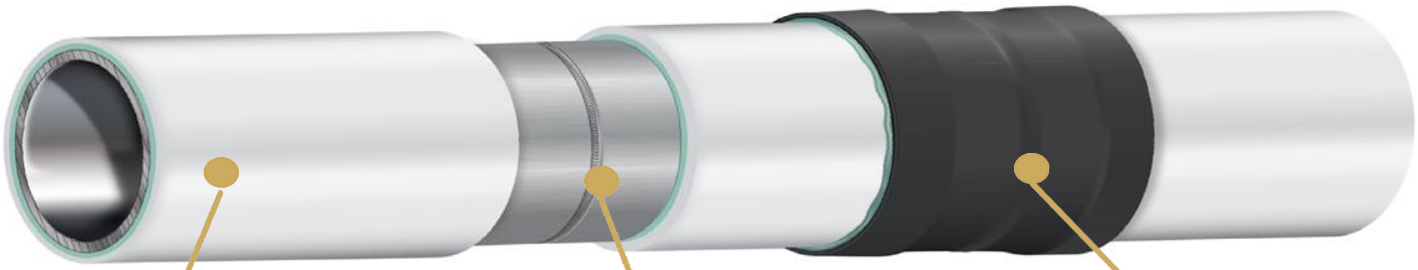
3. Smart, Connected Application



Example:
Liquid Epoxy
Applied Coating
Systems

End-to-End Pipeline Coating Solution

High Performance MLC+ High performance FJC+ Automation and Data Collection



Automated Pipeline Coating Data

Automated Ultrasonic Weld Inspection Data

Automated Field Joint Coating Data

Conclusion

- There has been advancements in FJC Technologies that helps making pipelines **Safer** and **More reliable.**
- Field joint coating needs to be an integral part of the continuous protection system to eliminate “weak links”

Future areas of advancements:

- Easy to apply high performance field joint coatings
- Pipeline integrity improvement by leveraging automation and digital innovation for coating applications
- Dynamic, in-service pipeline data including sensors installed in the field joint to measure and monitor pipeline performance while in service
- More End-to-End solutions

Thank You!

SOMAIEH SALEHPOUR, PhD
General Manager, Canusa-CPS
25 Bethridge Road, Toronto, ON M9W 1M7 Canada
o +1 416 744 5792 **m** +1 416 716 7022
e somaieh.salehpour@shawcor.com

SHAWCOR