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NoStickRolls Project Overview

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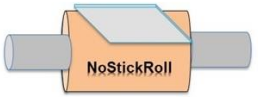
NoStickRolls Project

Non-**Stick**ing Furnace **Rolls** for steel products to improve service life and product quality in CAL & CGL (**NoStickRolls)** is a Research Project funded by the EU Research Fund for Coal and Steel programme (Grant agreement N° 754144)



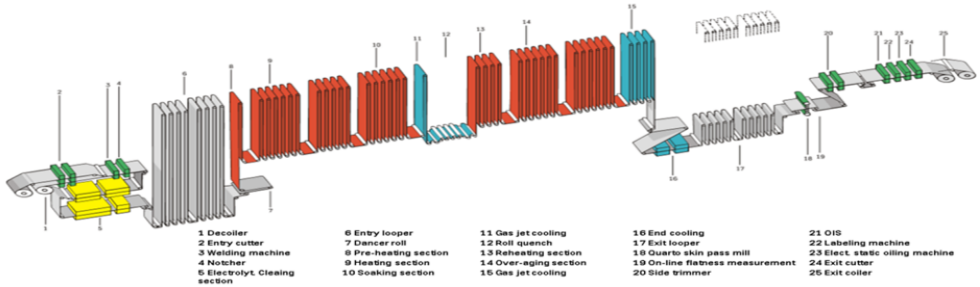
Scope of the Project: ⇒ extend the service life of furnace rolls working in CAL & CGL and to improve the steel strip's quality towards **wear and pick-ups defects**.

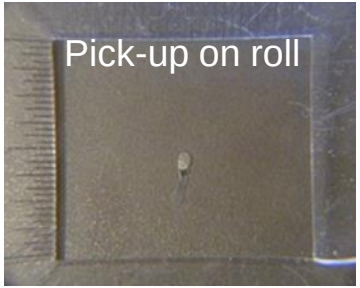
The pick-up formation issue has become more critical with the automotive industry demands for the development of ever more high-strength, high-ductility steel grades characterized by high Mn and Si contents and when adopting higher line speeds needed to increase the productivity.

NoStickRolls Project: Industrial issue

What are Pick-ups?

Matter from steel strips (oxides or Fe dust particles) that sticks and accumulates forming a lump on rolls working in vertical and horizontal continuous annealing furnaces. They form due to **mechanical and/or chemical interactions.**





What do Pick-ups cause?

- Scratching or denting the steel strip effecting the product quality
- Increase the shutdowns for machining/replacing coated rolls

NoStickRolls Project: Industrial issue

According to roll's position in the furnace, the pick-up type and formation mechanism is different

The **furnace atmosphere is reducing**: 2÷7%H_2/N_2 with a **dew point** of -50°C ÷ -20°C.

Heating & soaking zones: → 750 ÷ 850°C

- Oxide pick-ups: spinels (i.e., $MnAl_2O_4$, $Mn_{1.5}Cr_{1.5}O_4$,) formed by the **chemical reaction** between the selective oxidation of alloying elements on steel strips (MnO, SiO_2,) and the surface oxide layer on roll coatings (Cr_2O_3 and/or Al_2O_3).

Cooling & overageing zones: → < 500°C

- Fe pick-ups: are related to **mechanical slippage** due to roll/strip speed mismatch. Debris from the strip sticks on the roll's surface and starts to build-up.
- SiO_2 pick-ups when electrical steels are processed on CAL.

NoStickRolls Project: currently used coatings

Currently used Coatings

Thermal spray cermet coatings for furnace rolls working in CAL & CGL:

- ✓ blends of Cr_3C_2 and NiCr;
- ✓ carbides or/and oxides in MCrAlY

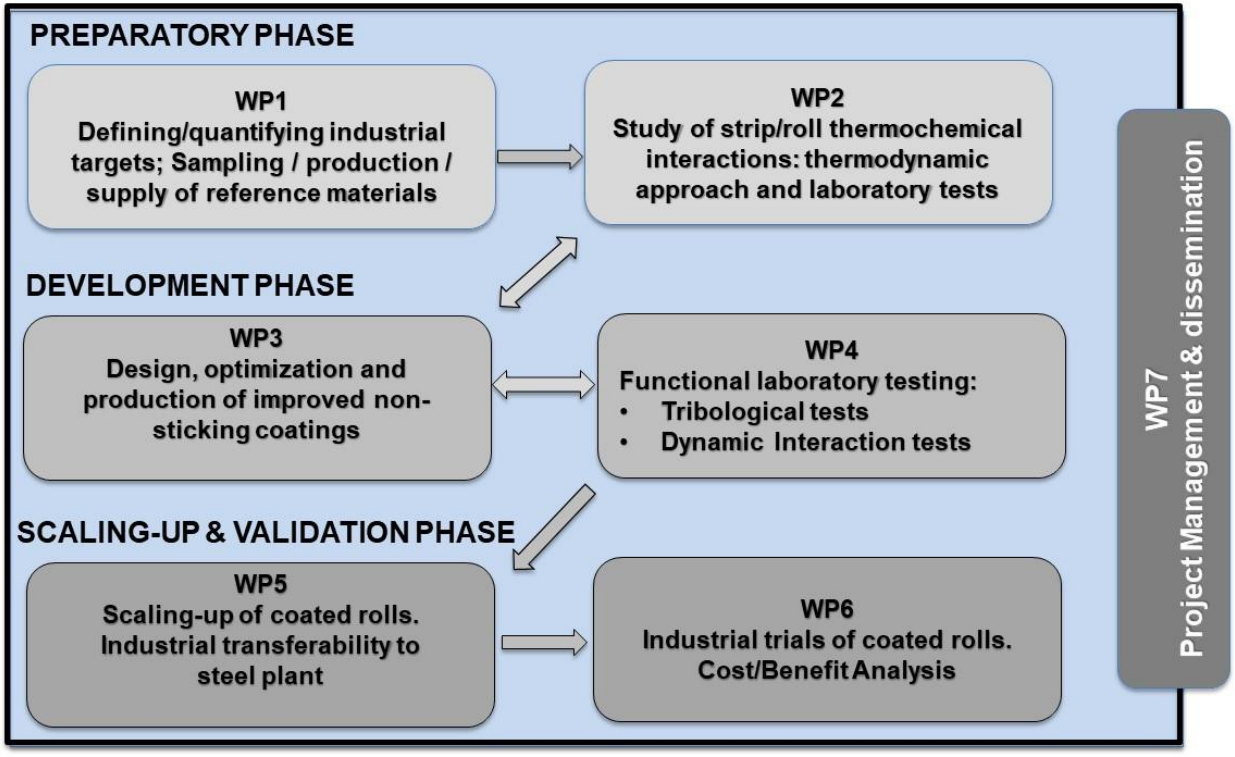
Required Coating Properties

- ✓ high hardness and wear resistance
- ✓ thermal shock resistance
- ✓ pick-up resistance
- ✓ sufficient surface roughness to avoid strip meandering.

NoStickRolls Project Objectives

- To acquire knowledge on the interactions occurring between materials in contact (rolls/steel strip) as a function of process variables (temperature, dew point, etc.) that can affect pick-up formation, and on trends of coating features (composition, surface roughness, etc.) that promote or inhibit mechanical and/or chemical interactions.
- To design and develop improved coating solutions using a combination of new material composition (or new for the application) and advanced and new in the field deposition techniques able to tailor the required coating's properties;
- To test and compare wear and pick-up resistance behaviour of different coating solutions respect to currently used ones by tribology tests and in-house developed test-bench facilities able to reproduce pick-ups at different temperatures;
- To scale-up and validate the most promising coatings compared to currently used ones by semi-industrial Roll-Strip-Interaction trials and by industrial trials in CAL & CGL.

NoStickRolls Project Structure



NoStickRolls Project Presentations

Interaction phenomena and pick-up formation mechanism on furnace roll coatings
Louis Bordignon, CRM

Anti-pick-up Coatings for furnace rolls in CALs & CGLs
Stefano Lionetti, Nicoletta Zacchetti, RINA

Study of wear and pick-up resistance properties of coatings by laboratory and pilot plant facilities
Jessica Schindhelm, Tuncer Uemit, Emaunel Tienpont, BFI

Production of coatings for industrial and semi-industrial trials
Andrea Chierichetti, Flame Spray; Tiberius Vilics, LWK PlasmaCeramic

Industrial Trials for Coating's Validation
Marc Blumenau, tkSE; Jean Michel Arbiol, AMS

NoStickRolls Project Conclusions

To suppress the formation of very adherent Fe pick-ups on rolls in the overageing zone, a WC-CrC-Ni cermet powder deposited by HVAF is proposed.

It is new for this application and is expected to have improved response to long-term in-service exposure compared to currently used cermet coatings.

- \+ It has appropriate hardness
- \+ It inhibits sintering phenomena as the metal binder is low (7 wt%).
- \+ Its thermal shock resistance at < 500°C is sufficiently good
- \+ it has a Co free matrix that complies with the latest REACH regulations.
- The surface roughness should be Ra 3.0 - 3.5 μm being a compromise to ensure a good strip quality but have some roughness to avoid strip sliding onto the rotating roll.

NoStickRolls Project Conclusions

The following coating solutions are proposed to avoid the formation of sticky Mn-rich spinel pick-ups on rolls in the soaking zone:

- Cermet coatings having no or a limited amount of Al and Cr in the Ni/Co based binder.
- Cermet coatings submitted to a plasma nitriding process aimed to transform Cr and CrC into CrN hard phases.
- Hard ceramic coatings that don't react with MnO.

The semi-industrial RSI tests carried out at 850°C in H_2/N_2 atmosphere with HSS strip showed significantly less pick-ups on the as-coated area of the nitrided Cr_3C_2-NiCr coating → hardening process has an effect in limiting pick-up formation.

No pick-ups were detected on the smoother area of nitrided Cr_3C_2-NiCr and Al_2O_3-TiO_2 coatings. Roughness seems to have an important effect on pick-up formation.

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