SUCCESS STORY

IC-MPPE / Integrated Computational Materials Process and Product Engineering

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Centre (K2)

Project P3.3 "Model based smart planning of processes across the hot-dip galvanizing process chain"

Multi-firm project (2017-2021)

Galvanized steel strips with best surface quality due to computer-optimized process control ©phonlamaiphoto-stock.adobe.com

WITH SPEED OF SOUND TO THE PERFECT SURFACE OF STEEL STRIPS

COMPUTER SIMULATIONS ARE THE KEY TO MORE ENVIRONMENTALLY FRIENDLY ANTI-CORROSION COATINGS FOR STEEL STRIPS

For decades the coating of steel strips with zinc has been a proven technology to protect them from rusting. Particularly in the automotive sector, great attention is given to the smoothness and uniformity of the thickness of zinc coatings. The smoother the zinc layer is, the less paint layers are required for a high-quality paint surface, the more even the layer thickness is, the less zinc has to be applied. The smoothness and uniformity of the coating thickness are important quality features and represent a decisive competitive factor, but they also contribute to protecting the environment.

Zinc coatings today are predominantly produced using the so-called hot-dip galvanizing process. The bright steel strip is passed through a bath of liquid zinc, whereby a relatively thick zinc layer with thickness fluctuations adheres to the steel surface. The subsequent process step is decisive for the desired layer thickness and high smoothness. In this process, a flat jet of air is directed almost vertically across the entire width of the steel strip onto the zinc layer, which is still liquid, and the excess zinc is "stripped off". What remains is a microscopically thin zinc coating. The layer thickness uniformity and smoothness, however, are limited by the formation of waves caused by turbulence in the nozzle jet.

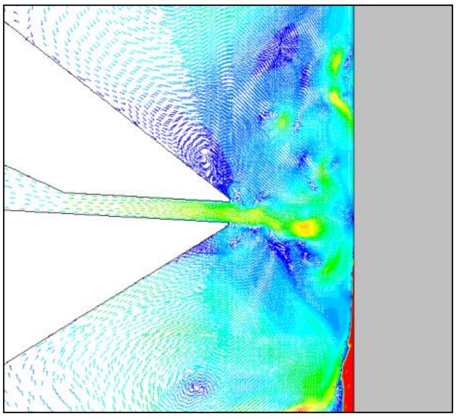
The challenge now is to better control the air jet stream, which hits the steel strip at almost the speed of sound, in order to produce smoother layers with a better thickness uniformity.

SUCCESS STORY

Simulation and Big Data Analysis as the Key to Process Optimization

At MCL, a simulation model was developed that reproduces the "stripping" process step in detail. In order to analyze the formation of waves, the air jet stream and the micrometer-thin zinc layer were recorded simultaneously (figure on the right). A special computer tool was developed for the characterization of the nozzle jet, which analyses the nozzle jet and its turbulence on the basis of very large simulation data fields. As a result, both the local and the temporal characteristics of the nozzle jet behavior are delivered.

For the first time it could be shown that there are low-frequency fluctuations of the nozzle jet which correlate with the formation of waves. The new findings on wave formation enabled a computer-aided further development of the stripping process towards even smoother coatings with the lowest possible thickness fluctuations. The simulation and computer tools developed in this project also open up the possibility of "testing" new nozzle designs in advance quickly and efficiently on the computer without the need for time-consuming prototype production and operating tests.



Results of the computer simulation: Sectional view of the wiper nozzle (white), the flow (vector representation) and the steel strip (grey) with the adhered zinc layer (red). Image: MCL

The gained knowledge and the developed computer tools secure the position of the company partner as a manufacturer of hot-dip galvanized steel strip in the highest quality segment. The key to the quality improvements achieved was the use of the newly developed simulation and computer analysis tools, which made the leap in quality possible in the first place and rendered resource-intensive operating tests unnecessary. Finally, an important contribution to environmental protection is also achieved, as the average zinc layers can be made considerably thinner and fewer layers of paint have to be applied in the subsequent painting processes.

Project coordination
Dr. Georg Reiss
Key Scientist Digital Manufacturing Processes
Materials Center Leoben Forschung GmbH
T +43 (0) 3842 45922 – 44
georg.reiss@mcl.at

Materials Center Leoben Forschung GmbH
Coordinator COMET-K2 Center IC-MPPE
Roseggerstrasse 12
8700 Leoben
T +43 (0) 3842 45922-0
mclburo@mcl.at
www.mcl.at

Project partner

- voestalpine Stahl GmbH, Austria
- International Zinc Association, USA
- Montanuniversität Leoben, Austria

This success story was provided by the centre management and by the mentioned project partners for the purpose of being published on the FFG website. IC-MPPE is a COMET Centre within the COMET – Competence Centers for Excellent Technologies Programme and funded by BMK, BMDW, and the federal states of Styria, Upper Austria and Tyrol. The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet

Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

Federal Ministry
Republic of Austria
Digital and Economic Affairs

Austrian Research Promotion Agency
Sensengasse 1, A-1090 Vienna
P +43 (0) 5 77 55 - 0
office@ffg.at
www.ffg.at