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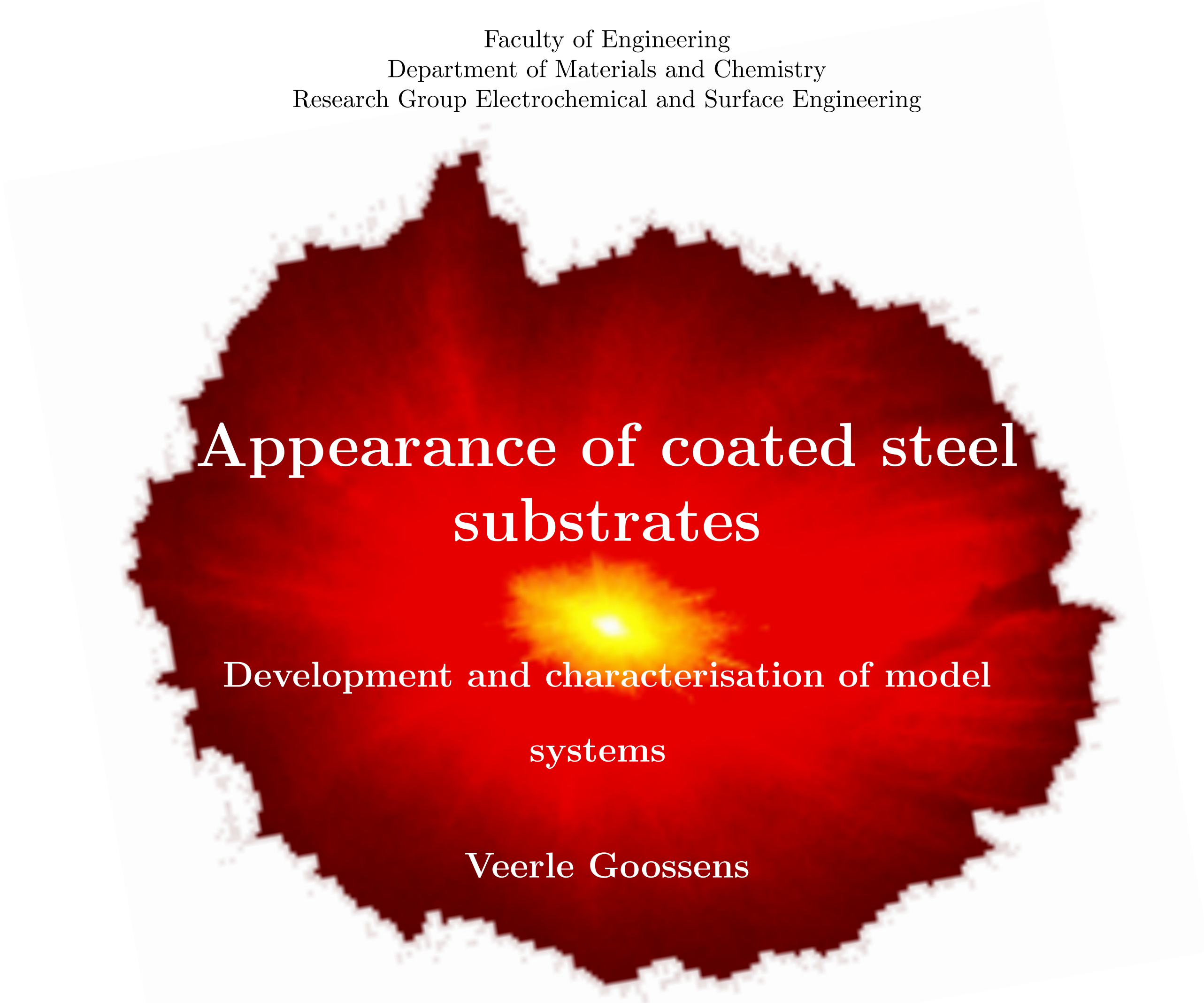

Appearance of coated steel substrates

Development and characterisation of model systems

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Summary

As the competition grows, manufacturers are paying increasingly more attention to the appearance of their products. The quality of similar products of different companies is often comparable, therefore the difference must be made in the appearance of it. customers are very sensitive towards the presentation and the appearance of a product. It has to draw the attention of the customer on the shelf and at the same time emphasise the quality and properties of the product. Not only in consumer products, but also in architectural applications the appearance is of paramount importance. Metal surfaces are frequently used in architectural design. Often because of their mechanical properties, but nowadays also for their reflective properties. As the metal itself is visible to the customer it needs to look spotless. Surface treatments and coatings are applied to it and at the end of the line the sheet is inspected to see if it meets the demands of the customer. If it does not it is discarded and the process parameters adjusted. This procedure is repeated until the appearance of the metal sheet satisfies the requirements.

Over the past decade the interest in the appearance of coatings has grown. The importance of the reflective properties of materials is recognised and investigated. In our research we want to simulate the distribution of the scattered light using physical models and also use this simulation to calculate the colour and the gloss of the surfaces. These values are then compared to experimental values to validate our model. This allows for a link based on physical scattering theories between surface characteristics and visual perception.

As a case study a steel surface was coated with a transparent polymer coating and iron oxide layers. Our research was divided in three parts. In the first part a model was constructed to predict the colour of coated steel substrates. The substrates were polished to eliminate the influence of the roughness on the colour. The model is based on the Fresnel equations and requirs the optical constants and thickness of the different coatings as input parameters. These were obtained with spectroscopic ellipsometry. The simulated colours displayed a close resemblance to the experimental colours.

In the second part the distribution of the reflected light as a function of the scatter angle was investigated. The substrate was roughened and no coatings were applied to it. An appropriate scattering theory was chosen and used to calculate the reflection of the samples. The Power Spectral Density of the surface had to be entered into the model as a parameter. It was shown that a spatial frequency range of $0.14\mu\text{m}^{-1}$ to $1.37\mu\text{m}^{-1}$ is needed to obtain a good match between experimental and simulated values. Using the simulated reflection values the gloss of the samples could be determined. Again an excellent correlation was seen between experimental and calculated values.

In the third part the rough substrates were coated with the transparent polymer coating and the oxide layer. The information of the previous models was combined and extended to account for the influence of the coatings on both the colour and the gloss. As the samples were roughened it became more difficult to use ellipsometry to determine the layer thickness and optical constants directly from the samples. Therefore the values obtained in the first part are used. This yielded a close resemblance of both the experimental colour and gloss and the simulated values.

We have succeeded in our aim to accurately predict the appearance of coated rough steel samples.