

Automation of nuclear material cladding coating measurement process

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**VYSOKÁ ŠKOLA
CHEMICKO-TECHNOLOGICKÁ
V PRAZE**

Data

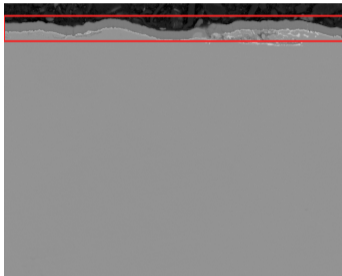


Figure 1: Example picture with coating

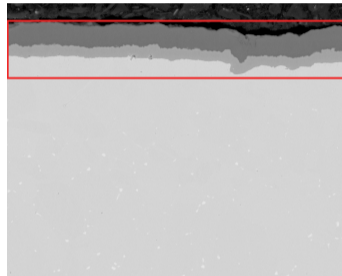


Figure 2: Example picture with coating

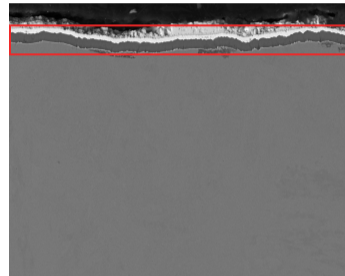


Figure 3: Example picture with coating

Manual Measurement

Figure 4: Animation showing an example of manual measurement in Fiji[1]

[1] Johannes Schindelin et al., Fiji: an open-source platform for biological-image analysis, 2012).

Types of Labels on SEM Image



Figure 5: Polygon mask

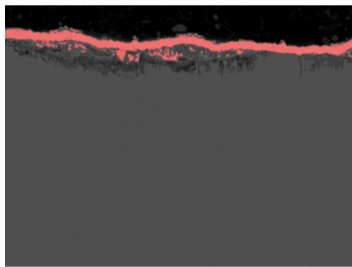


Figure 6: K-Means mask

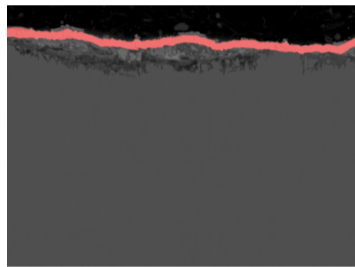


Figure 7: Refined K-Means

Image Segmentation with U-Net

- **Model:** Convolutional Neural Network U-Net [2]
- **Library:** `segmentation_models_pytorch` [3]
- **Hyperparameter tuning:** Optuna [4], based on `val_loss`
- **Performance:** Intersection over Union = 95.47%

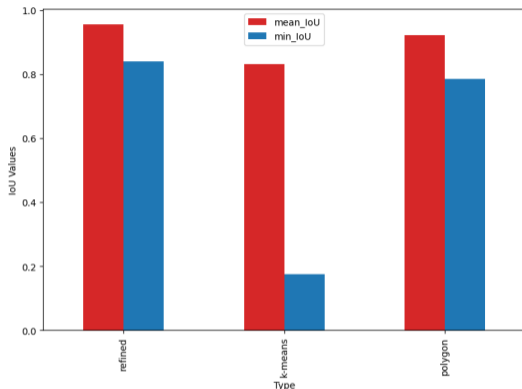


Figure 8: Comparison of mean and min IoU for different labels

- [2] O. Ronneberger et al., U-Net: Convolutional Networks for Biomedical Image Segmentation, 2015.
[3] P. Iakubovskii, Segmentation Models Pytorch, 2019.
[4] T. Akiba et al., Optuna: A Next-generation Hyperparameter Optimization Framework, 2019.

Image Segmentation with U-Net: Results



Figure 9: SEM Image, Ground Truth, and Model Prediction with $\text{IoU} \approx 97\%$



Figure 10: SEM Image, Ground Truth, and Model Prediction with $\text{IoU} \approx 87\%$

Integration to Fiji

Figure 11: Animated example workflow in Fiji

Summary

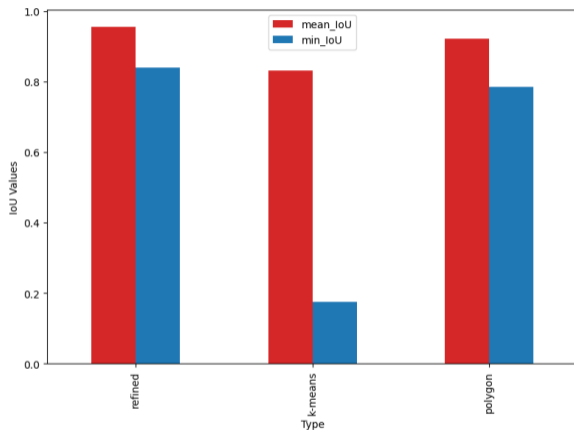
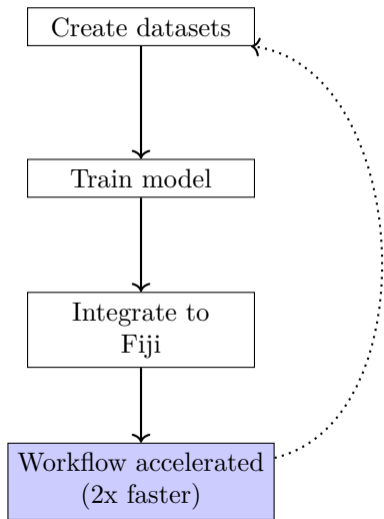


Figure 12: Comparison of mean and min IoU for different labels

Acknowledgments

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Q & A

Any questions?

References

- [1] Johannes Schindelin et al. “Fiji: an open-source platform for biological-image analysis”. In: *Nature methods* 9.7 (2012), pp. 676–682.
- [2] Olaf Ronneberger, Philipp Fischer, and Thomas Brox. *U-Net: Convolutional Networks for Biomedical Image Segmentation*. 2015. arXiv: 1505.04597 [cs.CV]. URL: <https://arxiv.org/abs/1505.04597>.
- [3] Pavel Iakubovskii. *Segmentation Models Pytorch*. https://github.com/qubvel/segmentation_models_pytorch. 2019.
- [4] Takuya Akiba et al. “Optuna: A Next-generation Hyperparameter Optimization Framework”. In: *Proceedings of the 25th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*. 2019.