

Introduction

This contribution study the adhesion of geopolymer (GP) layers in the form of coatings on two types of underlying substrates. The first part of the research was to compare single-layer and three-layer coatings without dopants. The next part of the research was effect of TiAlMo dopant on geopolymer coatings, which was added in concentration of 1%, 5% and 10% to increase the stability of the coating layers. Single-layer coatings doped with TiAlMo particles were compared with nondoped coatings. The adhesion of the coated layers was determined by using a grid test.

Materials and Methods

Aluminum (EN AW 6060) and construction steel 1.0038 (EN 10025-2) were chosen as the underlying substrates, corresponding with previous research [1,2]. Application of coatings by painting with a brush was chosen for all types of underlying substrates as a cheap and fast-creating method. Geopolymer with the designation J, described in previous research [1,2], was chosen. The basis of this geopolymer was alkali-activated metakaolin, specifically H^+ matrix modified by Al, created by mixing H_3PO_4 with Al_2O_3 nanoparticles in iPrOH.

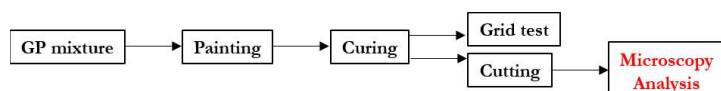


Figure 1. Scheme of preparation of Geopolymer samples

Grid test

The grid is rated from category 0 to 5 according to the criterion of how much coating has peeled off around the cuts. The table is used to determine the value. Table for evaluating the grid test according to ISO 2409 [3]. The results showed that all geopolymers on the Al substrate had a rating of 1, while the geopolymers on the Fe substrate had a worse rating than 1. The results from the grid test with a detailed surface characterization (LEXT, SEM) of the coating structure on different types of underlying substrates will help to design the application of these investigated coatings.

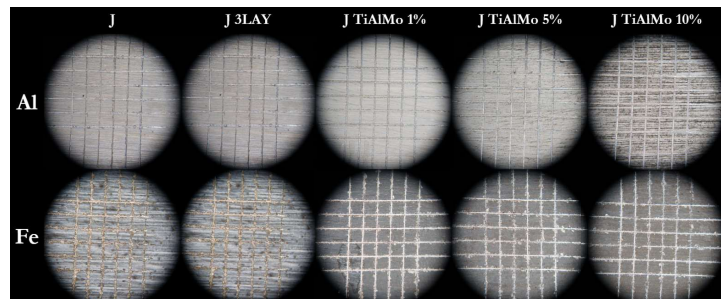


Figure 2. The grid test results

Table 1. Evaluation of the grid test

Grid test	J	J 3LAY	J TiAlMo 1%	J TiAlMo 5%	J TiAlMo 10%
Al	1	1	1	1	1
Fe	3	3	2	3	2

Conclusions

- At all selected concentrations, i.e. 1, 5 and 10%, the coating formed by geopolymer on Al and Fe substrate for both types of dopants is very similar to the coating without particles. The differences are mainly visible in the presence of particles increasing with increasing dopant concentration.
- Coating layers for both underlying substrates showed a number of cracks that are stable and without signs of peeling.
- The grid test showed that neither the particles used nor the concentration of particles in the suspension had no negative or positive effect on the adhesion of the coating to the underlying substrate.
- The better adhesion resulting from the Grid test for the Al underlying substrate was due to the good stability of the Al passivation layer. The Fe underlying substrate had unstable corrosion products leading to reduced adhesion.
- These coatings could be used in industry as protective coatings.

References

- [1] Novotný J., Jaskevic M., Mamon F., Mares J., Horký R., Houska P. Coatings 2022, 12, 1695.
- [2] Mares J., Mamon F., Jaskevic M., Novotný J. Manufacturing technology 2023, 23, DOI: 10.21062/mft.2023.024.
- [3] ISO 2409:2020(en), Paints and varnishes – Pull-off test for adhesion.

Acknowledgements

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Microscopy analysis of Geopolymer coatings

Characterization of coatings on Al and Fe underlying substrates using SEM and LEXT analysis showed the presence of cracks on the surface. The cracks appear stable and no flaking is present. Particles of the TiAlMo dopant are present and their increasing amount with increasing concentration is noticeable. An interesting phenomenon was the triangular particles present only in samples with dopant. According to EDS, they do not contain the elements Ti, Al and Mo, but have a high proportion of P.

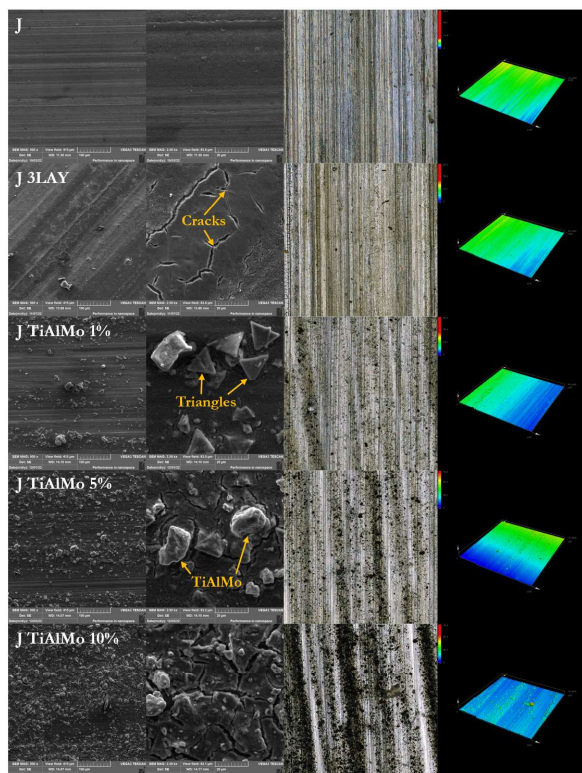


Figure 3. Comparison of results from SEM and LEXT microscopy characterization for Al underlying substrate

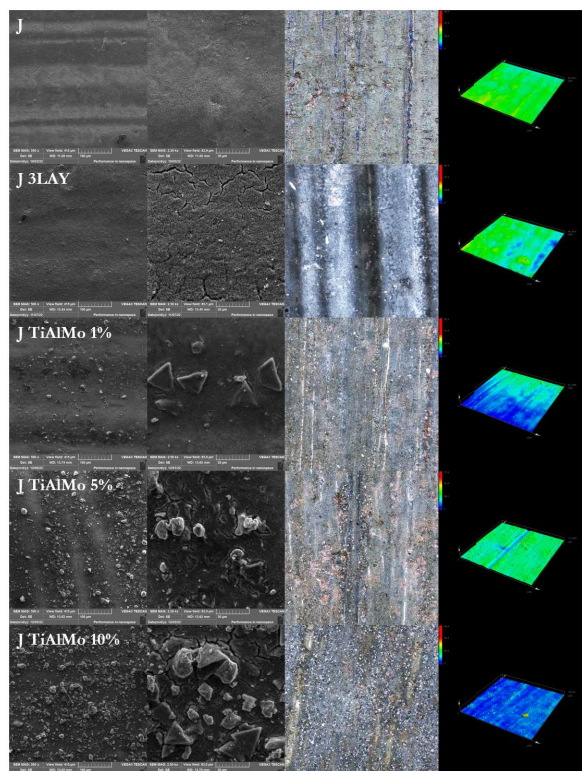


Figure 4. Comparison of results from SEM and LEXT microscopy characterization for Fe underlying substrate