DECHEMA FORSCHUNGSINSTITUT

Preparation of nanoparticle-modified anodizing layers for increased alkali resistance

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Motivation

- Aluminium alloys are important materials in lightweight construction
- Anodizing is a frequently used surface treatment for corrosion protection of aluminium alloys in automotive and aerospace applications
- For sufficient corrosion resistance sealing is necessary, but common sealing methods (e.g. hot water sealing) are not protecting against strong bases
- Aluminium oxide is stable till a pH of 8.6 is reached, but chemical cleaners are often far more basic
- Alkali resistance can be achieved by impregnation of the surface and pores with suitable nanoparticles, e.g. from ZrO_2

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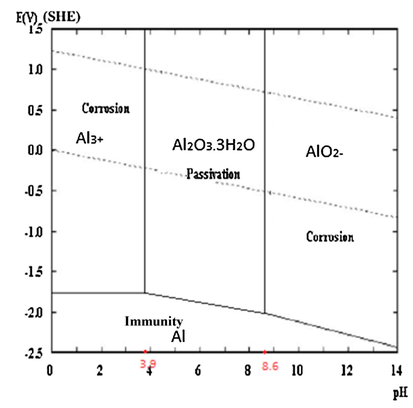
Pourbaix diagram of Aluminium

- Passive region between pH 3.9 – 8.6
- At lower pH-value Al^{3+} is formed
- At higher pH-value aluminates are formed



R. Bubbico et al., Chem. Eng. Res. Des., Volume 104 , 605 – 614.

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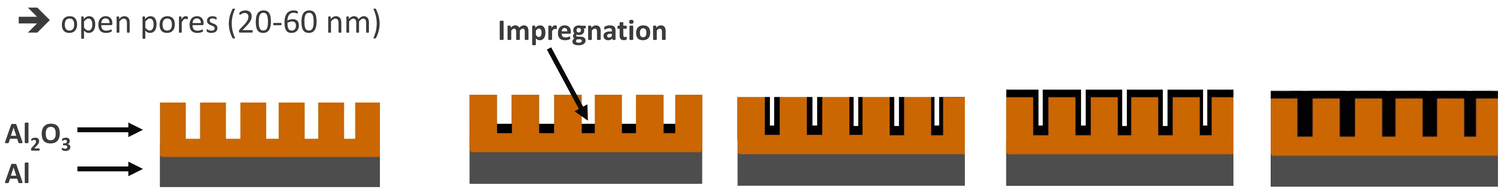
Approach

Preparation of oxide-layer and impregnation

Step 1: Anodizing process

➔ open pores (20-60 nm)

Step 2: ZrO_2 nanoparticle based impregnation



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DOLAPIX (by Zschimmer & Schwarz)

- Polyelectrolytes (charged polymers)
- Used for ceramical slurrys in industrial application
- Wraps particles for stronger repulsion
- Change of zeta-potenial
- Stabilisation of dispersions
- Lowers viscosity

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Aqueous ZrO_2-dispersions

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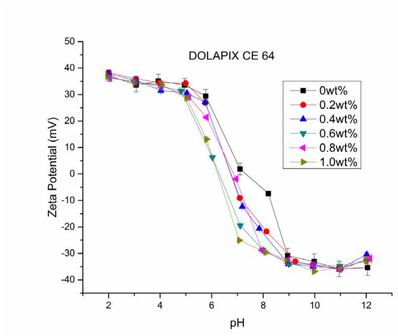
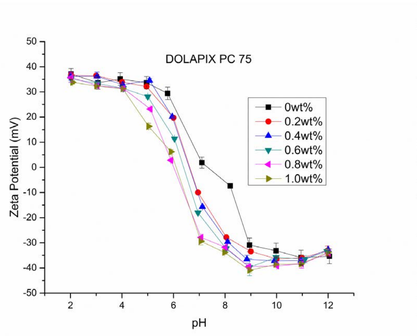
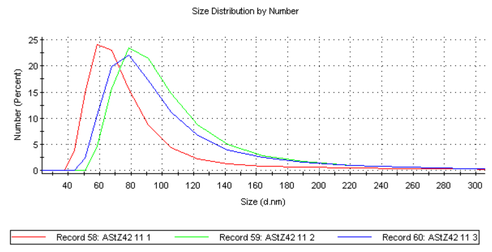
Zeta-Potential in respect to pH







Particle size with 1 wt% DOLAPIX PC 75 @ pH 8.95

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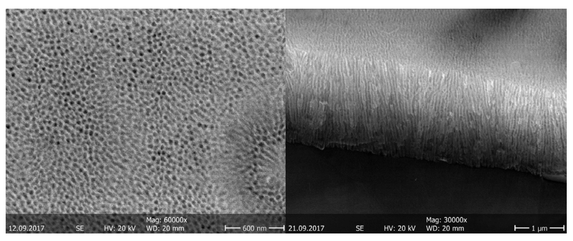
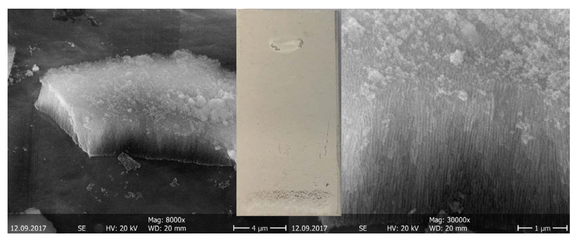
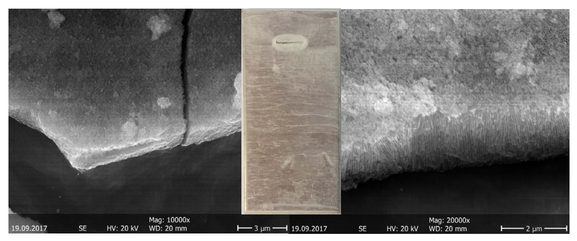
Dip-coating



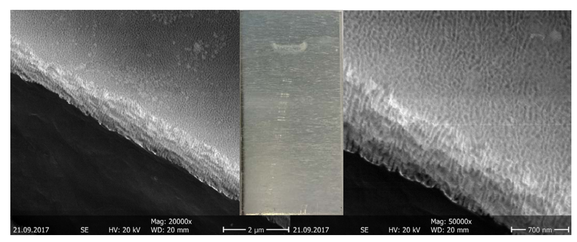
PAA @ AA2024 /Pore size ~ 50 nm



pH 9.14, 20 wt%, 15 mm/min



pH 9.72, 10 wt%, 15 mm/min



pH 9.01, 5 wt%, 15 mm/min

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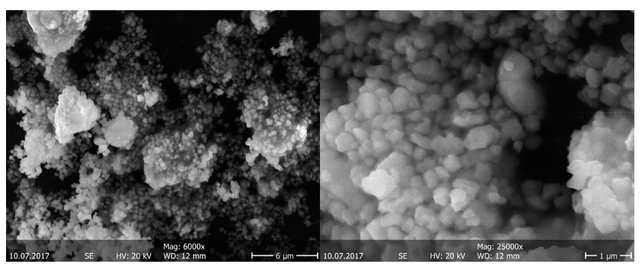
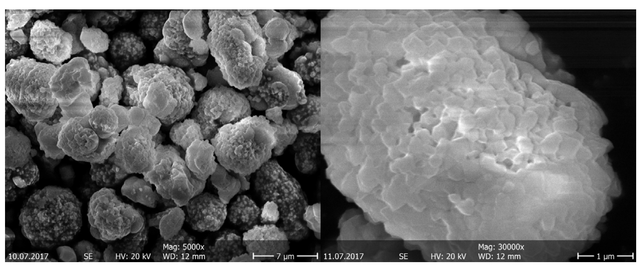
Milling of microparticles by Ultrasound



5 µm ZrO_2 (Sigma-Aldrich)



ZrO_2-particles after 15 min US-treatment

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Conclusion

- Preparation of stable ZrO_2-dispersions is possible between pH 2-5.8 and 8.7-12
- Addition of 1 wt% Dolapix PC 75 results in highest zeta-potenial ~ -40 mV
- Dip-coating in 5 wt% ZrO_2-dispersion probably fills the pores
- By milling µm-sized particles costs can be reduced

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