

# Influence of pH-variation with two different acids of 0.9% saline solution on the corrosion behaviour of two experimental dental CoCr alloys with the same PRE

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## Introduction

Through food and drink, various acids reach the oral cavity. In biofilms, lactic acid is produced, and gastric acid secretion leads to an extremely strong lowering of the pH. These changes in pH can influence corrosion processes in the oral cavity.

## Aim of the study

The aim of this study was to simulate such pH conditions and to compare the electrochemical corrosion behaviour of 2 experimental CoCr alloys with the same pitting resistance equivalent (PRE) value in 0.9% saline solution (pH 6.3) which was additionally adjusted with 2 different acids (0.02 M HCl and lactic acid) to the pH-values of 5, 4, 3, 2.

## Materials and Methods

The experimental dental alloys Co-28Cr-5Mo-1.5Si-Mn and Co-28Cr-10W-1.5Si-Mn with PRE=44.5 were used [1]. From each alloy, 6 specimens were prepared. 0.9% saline solution was used as a reference electrolyte. With the use of a pH-meter (691, Metrohm), the pH-values of the saline solutions were adjusted to pH 2, 3, 4 and 5 with either 0.02 M HCl or lactic acid. With each alloy and electrolyte, electrochemical corrosion measurements according to ISO 10271 were performed, which consist of an open-circuit-potential measurement over 2 h followed by anodic polarisation (-150 mV~E<sub>corr</sub> to 1 V, speed 1 mV/sec). From each measurement, the parameters E<sub>corr</sub> after 2 h, E<sub>z</sub>, E<sub>p</sub>, i<sub>p</sub>, i(300 mV), i(300mV+E<sub>z</sub>), i<sub>corr</sub>, R<sub>p</sub>, E(-6) and E(-5) were determined. With each parameter, an independent t-test was performed (p<0.05).

## Results

### Anodic polarisation plots

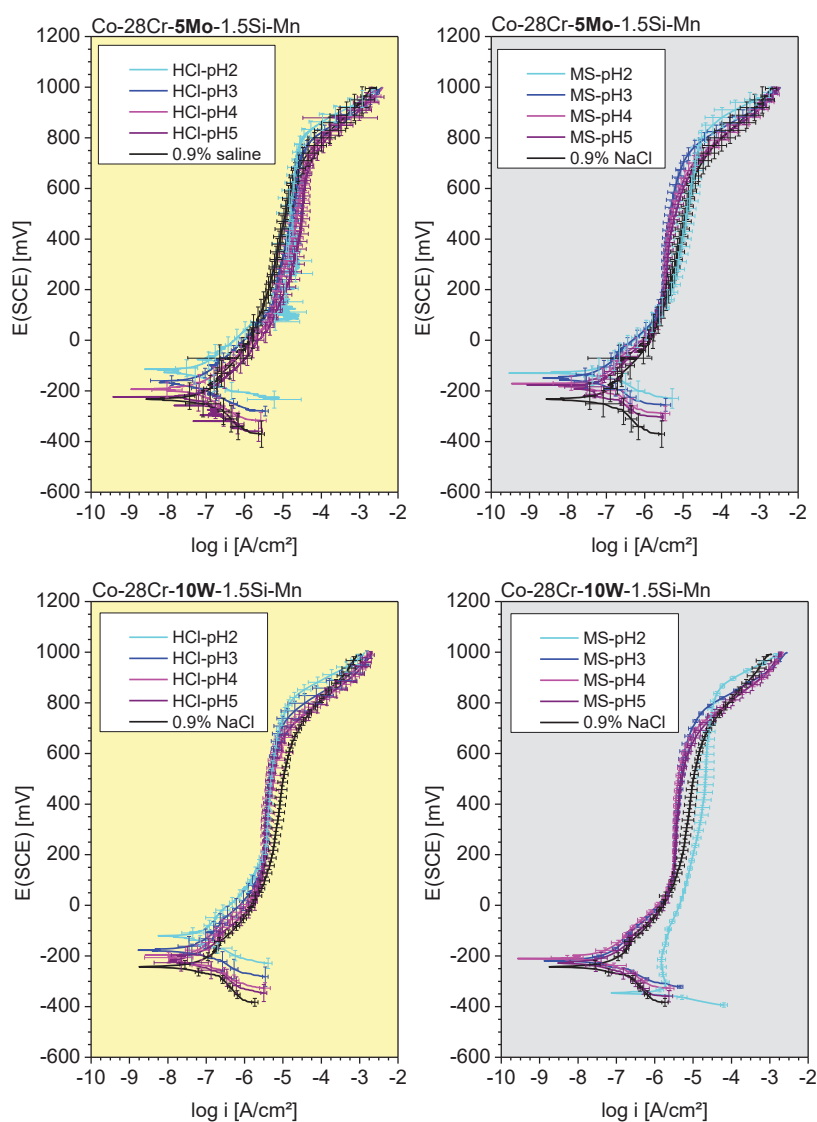


Fig. 1: Anodic polarisation plots for each alloy and both electrolytes

### Calculated parameters

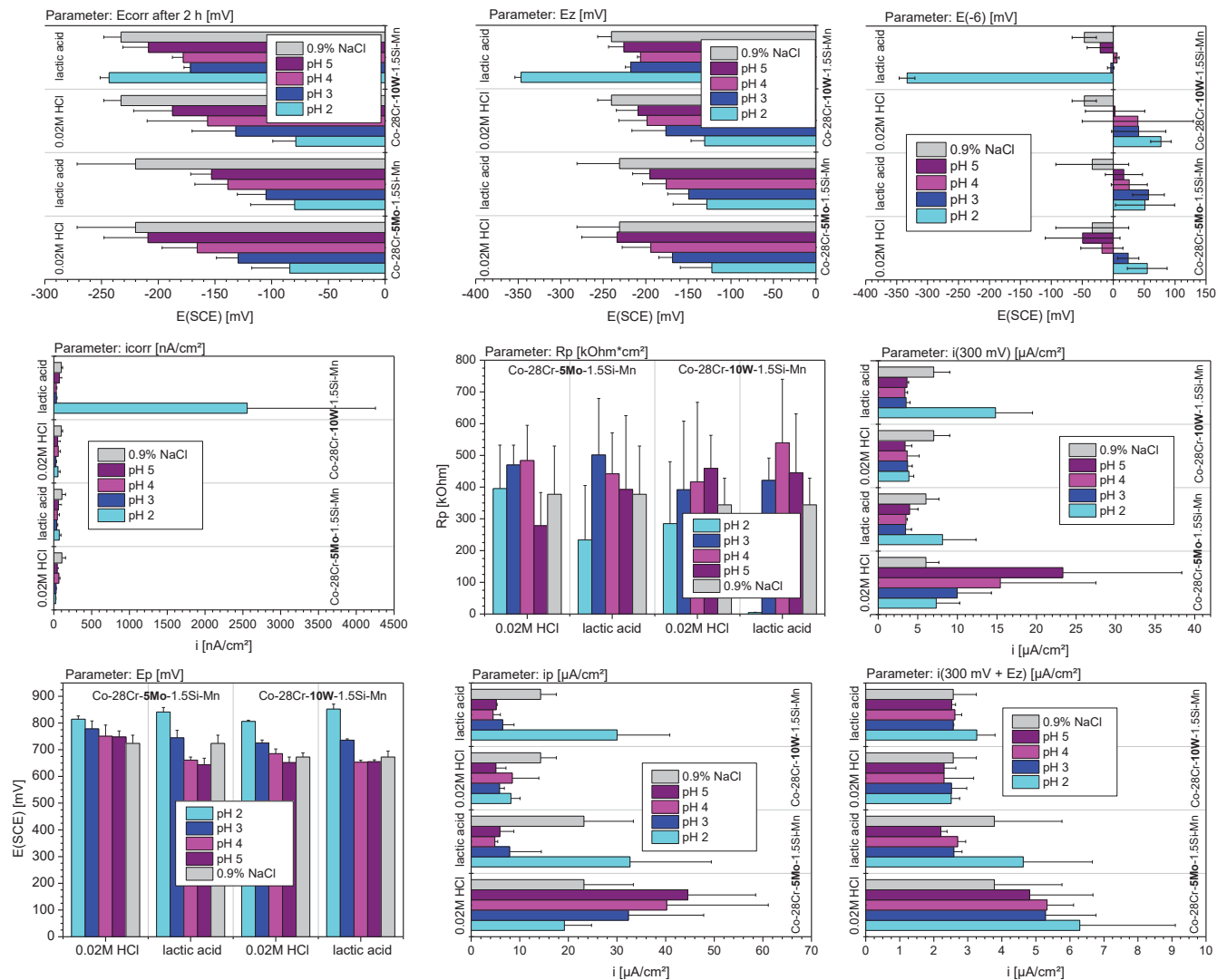


Fig. 2: Calculated parameters for each alloy depending on the pH of both electrolytes

## Summary

- Generally, the corrosion behaviour was different for both alloys and the acids used. The most prominent differences could be seen at pH 2 adjusted with lactic acid.
- With the exception of the calculated parameter R<sub>p</sub>, higher corrosion resistance could be determined with decreasing pH in a clear ranking for Co-28Cr-5Mo-1.5Si-Mn with 0.02 M HCl; however, in lactic acid only to pH 3.
- For Co-28Cr-10W-1.5Si-Mn, decreasing corrosion could be measured in both acids only to pH 3; a clear ranking was found only for the calculated potential parameters.

## Conclusion

The Mo-containing alloy showed good acidic corrosion resistance for all pH values used which were adjusted with 0.02 M HCl. This alloy is superior at a low pH-value adjusted with lactic acid compared to Co-28Cr-10W-1.5Si-Mn.

## Statistical calculation with the parameter icorr (example)

Tab. 1a/1b: Influence of pH value

0.02M HCl	Co-28Cr-5Mo-1.5Si-Mn	Co-28Cr-10W-1.5Si-Mn
H2 with H3	-	-
H2 with H4	+	-
H2 with H5	+	-
H3 with H4	+	-
H3 with H5	+	-
H4 with H5	-	-

Tab. 1c: Influence of acid type at a constant pH

	Co-28Cr-5Mo-1.5Si-Mn	Co-28Cr-10W-1.5Si-Mn
H2 with M2	+	+
H3 with M3	-	-
H4 with M4	-	-
H5 with M5	-	-

Tab. 1d: Comparison with the reference electrolyte (0.9% saline)

	Co-28Cr-5Mo-1.5Si-Mn	Co-28Cr-10W-1.5Si-Mn
H2 with KS	+	-
H3 with KS	+	-
H4 with KS	-	-
H5 with KS	+	-
M2 with KS	-	+
M3 with KS	-	+
M4 with KS	-	+
M5 with KS	-	-

Lactic acid	Co-28Cr-5Mo-1.5Si-Mn	Co-28Cr-10W-1.5Si-Mn
M2 with M3	-	-
M2 with M4	-	-
M2 with M5	-	-
M3 with M4	-	-
M3 with M5	-	-
M4 with M5	-	-

Tab. 1a-d: Example of statistical calculation (independent t-test, p < 0.05) with parameter icorr:  
+ significant  
- not significant

## References

- [1] Y. S. Al Jabbari: Physico-mechanical properties and prosthodontic applications of Co-Cr dental alloys: a review of the literature. J Adv Prosthodont, 2014, 6, p. 138-145

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## Contact

<http://www.mwt-tuebingen.de>

