

**Área: ANA***(Inserir a sigla da seção científica para qual o resumo será submetido. Ex: ORG, BEA, CAT)*

## Corrosion prediction of AZ31 Mg alloy using machine learning and digital cell phone images

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### Highlights

This approach demonstrated that combining smartphone-acquired digital images with machine learning and a 3D-printed device enables the rapid prediction of the corrosion of the commercial AZ31 alloy.

### Resumo/Abstract

The AZ31 Mg alloy is one of the most widely used magnesium alloys in combination with aluminum. This material exhibits significant application potential in the automotive, aerospace, and biomedical implant fields. However, its use remains a challenge due to its high susceptibility to corrosion in humid or saline environments. Traditionally, corrosion assessment is carried out through electrochemical tests and gravimetric analyses, which require specialized equipment, laboratory infrastructure, and long monitoring periods and are impractical for field applications. This work aims to apply machine learning integrated with digital image analysis from smartphone-captured images to predict the corrosion of the AZ31 alloy. The sample surfaces were cut and ground to obtain a uniform finish. Subsequently, they were exposed to a 3.5% NaCl solution in a controlled system for intervals of 0, 1, 2, 3, 4, 7, 10, and 14 days. Digital images of the corroded samples were acquired using a smartphone camera coupled to a 3D-printed device with an LED lamp inside. Data processing and modeling were performed in Python. The region of interest of the images was selected, and then the data augmentation technique was applied. Next, segmentation and feature extraction algorithms were employed, considering color attributes (RGB and HSV) and texture descriptors (GLCM, LBP, among others). The extracted features were organized into a data matrix (**X**) and analyzed using Principal Component Analysis (PCA) and a ridge regression-based classifier. PCA revealed a discrete differentiation among the samples according to corrosion time, with the 0-day condition (no corrosion) being the most distinct. Furthermore, two main clusters were identified: one comprising samples exposed for 1 to 4 days, and another comprising those exposed for 7 to 14 days. Subsequently, a supervised method was applied to classify the samples according to corrosion time. The optimized RidgeClassifier achieved an overall accuracy of 88.0%. The class-wise F1-scores were: 1.00 (0 days), 0.75 (1 day), 1.00 (2 days), 0.50 (3 days), 0.86 (4 days), 1.00 (7 days), 0.80 (10 days), and 1.00 (14 days). The proposed methodology demonstrated that combining smartphone-acquired digital images with machine learning tools makes it possible to predict the commercial AZ31 alloy's corrosion behavior rapidly. This approach is fast, portable, and cost-effective.

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