Testing Ceramics in Liquid Zinc for Upgrading Galvanising Bath Journal Bearings

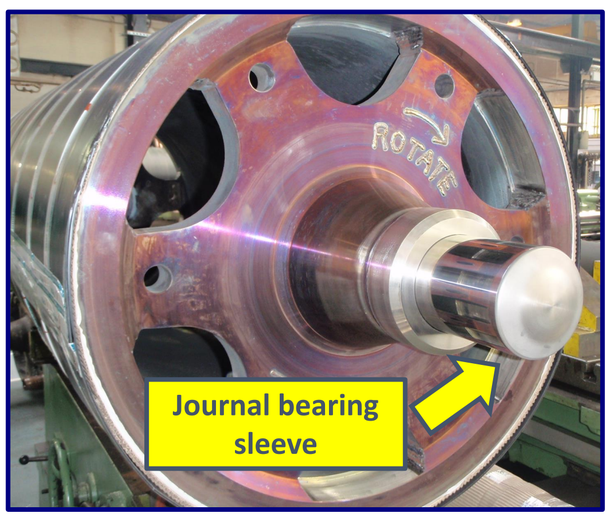
Giovanni Paolo Alparone[1] David Penney[1] Christopher Mills[2]

[1] Department of Materials Engineering, Swansea University, Swansea, West Glamorgan, SA2 8PP, United Kingdom

[2]Tata Steel UK, Research and Development, Swansea Technology Centre, Swansea, SA2 8PP United Kingdom

Introduction

Automotive grade galvanised steel must comply with stringent quality requirements and, for this reason, galvanisers are interested in extending the service life of the pot hardware, which is a bottleneck to production and quality of premium 'full-finish' product. The pot roll bearings are submerged in the galvanising bath and are subjected to deterioration due to the reaction of the bearing materials with the liquid zinc bath. Ceramic materials are chemically stable in molten metals and have the potential to outperform the bearing materials currently used by the industry.

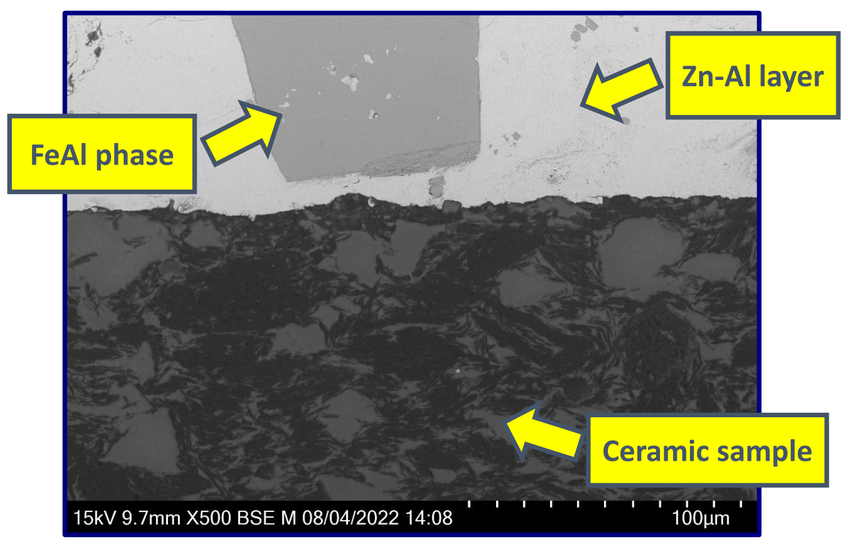


Methodology

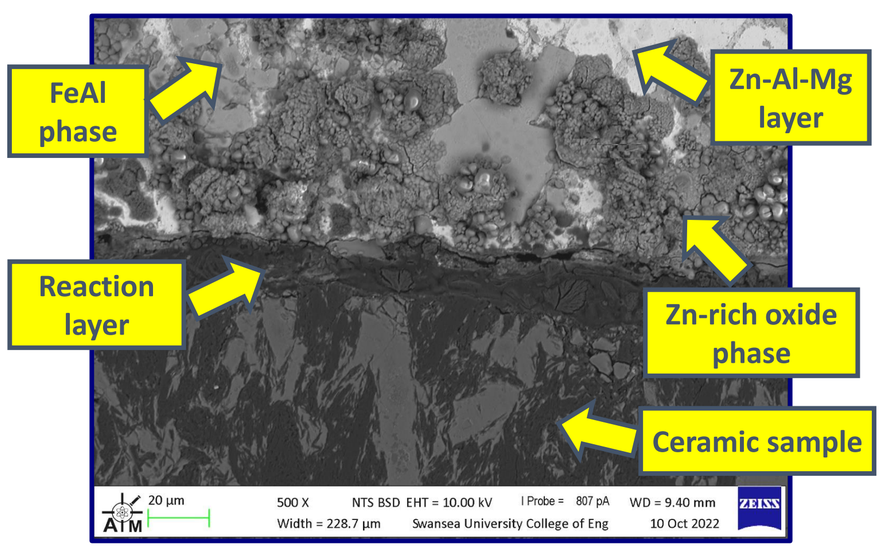
In this research, selected ceramics were immersed in liquid zinc alloy at 465°C for 5 weeks. Alumina, zirconia, silicon nitride, boron nitride, Shapal™ Machinable AlN and Macor® Machinable Glass Ceramic were immersed in two separate baths of different chemistry, namely zinc-aluminium (Zn-0.3wt% Al) and zinc-aluminium-magnesium (Zn-1.5wt% Al-1.5wt% Mg.) After testing, the samples were extracted from each bath and polished without removing the zinc. The interface between the zinc and the ceramic material was characterised with SEM and EDX to observe the interactions with the two molten metal baths.

Results

Zinc-Aluminium bath



Zinc-Aluminium-Magnesium bath



Discussion

The SEM images show two different M26 boron nitride samples after testing. M26 boron nitride is a ceramic containing 40% SiO_2 and 60% BN. The image for the sample tested in Zn-Al shows an FeAl phase in the Zn-Al layer due to the presence of Fe in both baths, which is not a concern as it was not found in the ceramic or at the interface. No intermediate or sub-surface layers were observed in this sample, hence it remained inert in Zn-Al. The image of the sample tested in Zn-Al-Mg also shows the presence of an FeAl phase. In addition to this, a zinc-rich oxide phase was observed. As shown previously, these phases are only present in the zinc layer. However, an 18 µm reaction layer was observed at the interface, as a result of the chemical attack by Zn-Al-Mg. Therefore, M26 BN is suitable for Zn-Al galvanising baths but corrosion still occurs in Zn-Al-Mg.

Conclusions

The research examined the suitability of various ceramics for use as galvanising bearings materials. After performing static immersion tests in two different zinc baths, it was found that:

1) The bath chemistry affected the performance of the material in molten metal as the ceramics behaved differently in different baths
2) Several samples, such as M26 BN, remained unreactive in liquid zinc alloy and, for this reason, have the potential to make optimised pot roll journal bearings with extended service time.

Acknowledgements

This project is supported by the European Social Fund through the Welsh Government and the EPSRC with Tata Steel UK.