Manufacturing and Verification of Air Foil Journal and Air Foil Thrust Bearings

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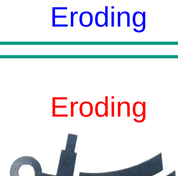
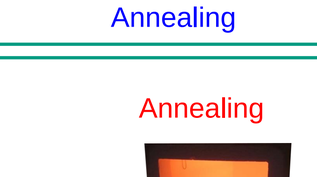
Introduction

- The **manufacturing process** of air foil journal and air foil thrust bearings is presented.
- The influence of the **embossing pressure** on the **manufacturing accuracy** of the bump foil is investigated by **3D optical measurements**.
- The **top foil and coating thickness** is determined by a light microscopic examination of **metallographic specimen**.

Applications

- Air cycle machines, turbo chargers, turbo compressors for fuel cell applications, etc.


[1]



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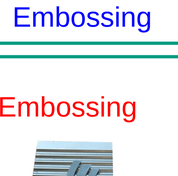
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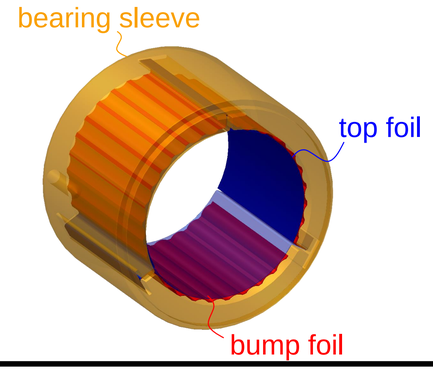
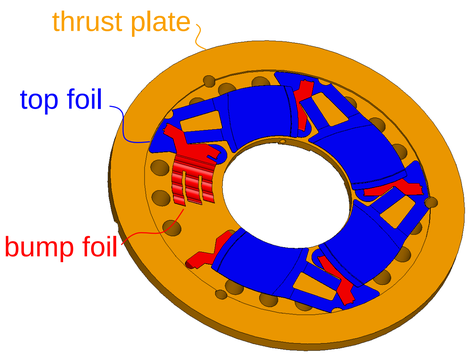
Air Foil Bearings:

Journal Bearing



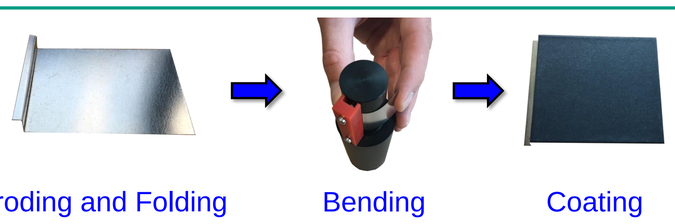
Thrust Bearing



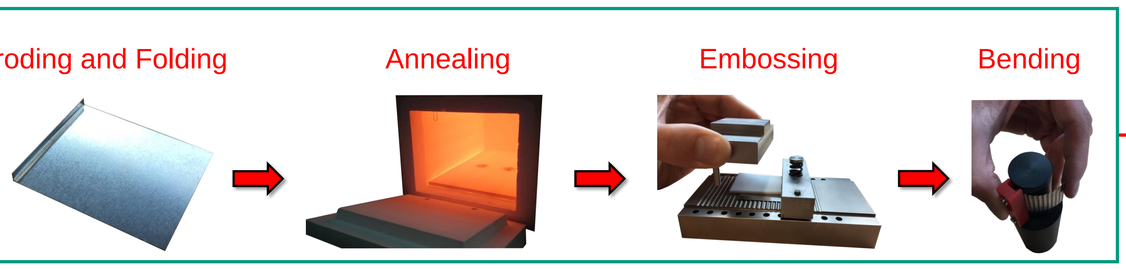
Journal Bearing Manufacturing

Manufacturing Process:

Top Foil



Bump Foil



Materials and Process Parameters:

Materials:

- Top and bump foil: X10CrNi18-8 (1.4310) → spring steel
- Top foil coating: Teflon
- Bearing sleeve: X5CrNiMo17-12-2 (1.4401)

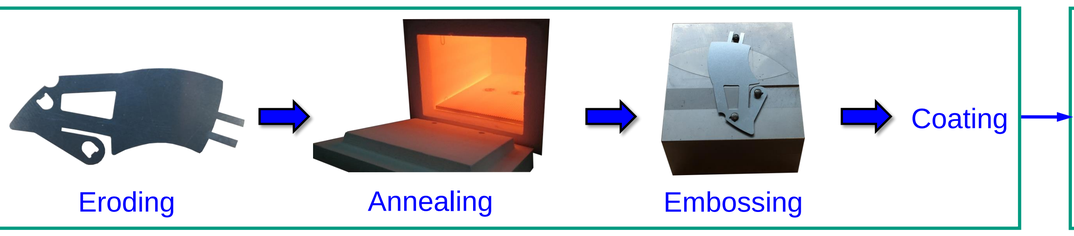
Process Parameters:

- Solution Heat Treatment: $T_s = 1050°C$ for 5 min. in an annealing foil, cooling in air according to DIN EN 10088-2
- Embossing pressure: $p_e = 18$ t

Thrust Bearing Manufacturing

Manufacturing Process:

Top Foil



Bump Foil

Materials and Process Parameters:

Materials:

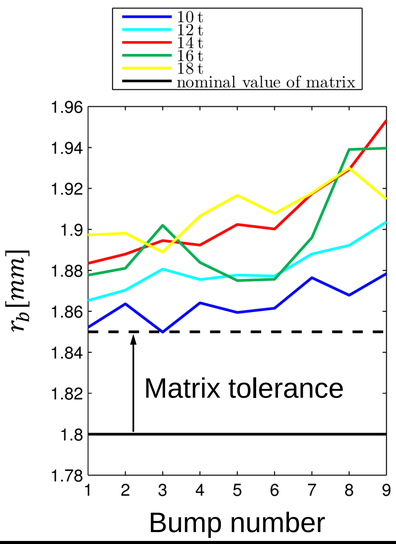
- Top and bump foil: X10CrNi18-8 (1.4310) → spring steel
- Top foil coating: Teflon
- Thrust plate: X5CrNiMo17-12-2 (1.4401)

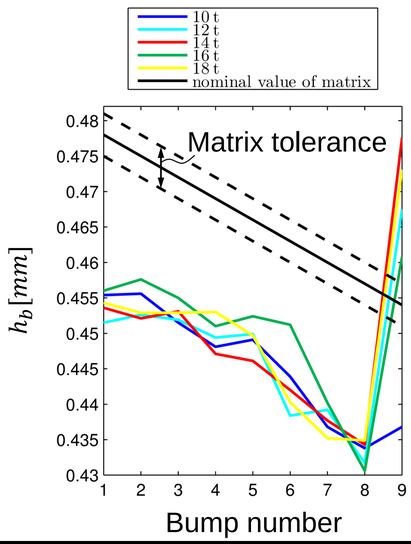
Process Parameters:

- Solution Heat Treatment: $T_s = 1050°C$ for 5 min. in an annealing foil, cooling in air according to DIN EN 10088-2
- Embossing pressure:
  => Bump foil: $p_e = 7$ t
  => Top foil: $p_e = 8$ t

Bump and Top Foil Verification

Effect of the Embossing Pressure on Bump Radii and Height:

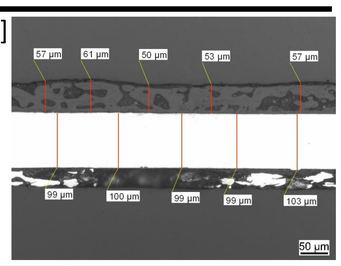




- **Differences** between measurements and nominal values of the matrix due to **spring-back effects** of the foil after the embossing process [4]
- Large foil thickness at the last bump due to **foil deformations** at the **holding down clamp**

Top Foil and Coating Thickness:

[5]



- **3 top foils** are tested
- **Metallographic specimen** at the middle of each top foil
- Examination of **top foil and coating thickness** at three areas in circumferential direction

Specimen	Material	Average Thickness Fixed End	Average Thickness Middle	Average Thickness Free End
1	top foil	100 µm	102 µm	100 µm
	coating	54 µm	56 µm	56 µm
2	top foil	101 µm	101 µm	101 µm
	coating	44 µm	44 µm	44 µm
3	top foil	99 µm	95 µm	96 µm
	coating	30 µm	44 µm	41 µm

[1] UTC Aerospace Systems. *Thermal Management Systems, Air Management Systems*. 2017 [cited 2017 30.05.2017]; Available from: http://utcaerospacesystems.com/cap/products/Pages/thermal-management-systems.aspx.

[2] Keun, R. and A. Zachary. *BUMP-TYPE FOIL BEARINGS AND FLEXURE PIVOT TILTING PAD BEARINGS FOR OIL-FREE AUTOMOTIVE TURBOCHARGERS: HIGHLIGHTS IN ROTORDYNAMIC PERFORMANCE*. in *ASME Turbo Expo 2015: Turbine Technical Conference and Exposition*. 2015. Montréal, Canada: American Society of Mechanical Engineers.

[3] Metz, D., et al., *Luftversorgung für Brennstoffzellen.* MTZ-Motortechnische Zeitschrift, 2013. **74**(4): p. 316-319.

[4] Shalash, K. and J. Schiffmann, *On the manufacturing of compliant foil bearings.* Journal of Manufacturing Processes, 2017. **25**: p. 357-368.

[5] Hoche, H. and C. Pusch, *Schichtdickenbestimmung an drei mit Teflon beschichteten Blechen*. 2017, Zentrum für Konstruktionswerkstoffe, Staatliche Materialprüfungsanstalt Darmstadt. F 17 0320.