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CORROSION BEHAVIOR OF AN ADDITIVELY MANUFACTURED FUNCTIONALLY GRADED MATERIAL

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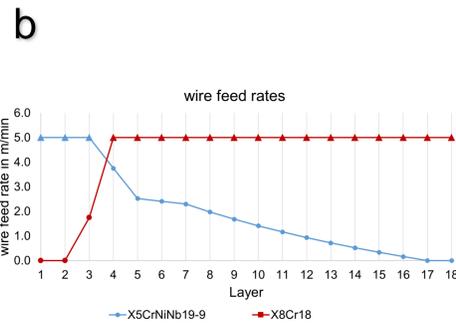
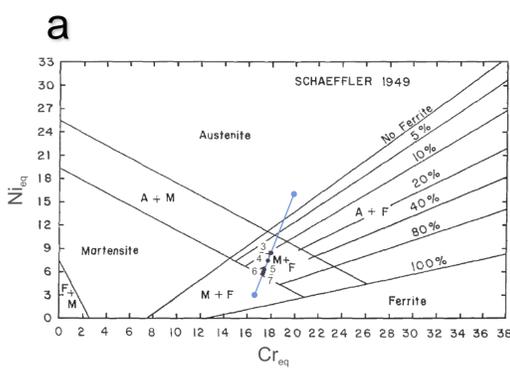


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Objectives

- manufacture FGM work pieces using wire arc additive manufacturing and cw-GMAW techniques
- study and understanding the corrosion behavior of FGMs
- compare the corrosion properties of FGMs with traditional DMWs
- evaluate the advantages of using FGMs over DMWs in terms of corrosion resistance

Methods and Materials



- traditional DMW versus FGM
- WRC-1992 and Schaeffler diagram (a)
- Austenitic X5CrNiNb19-9 and Ferritic X8Cr18
- choosing correct Cr_{eq} and Ni_{eq} for linear transition
- used wire feed rates (b) for electrode- and cold wire
- possible galvanic, intergranular and pitting corrosion
- electrochemical and salt spray test were conducted

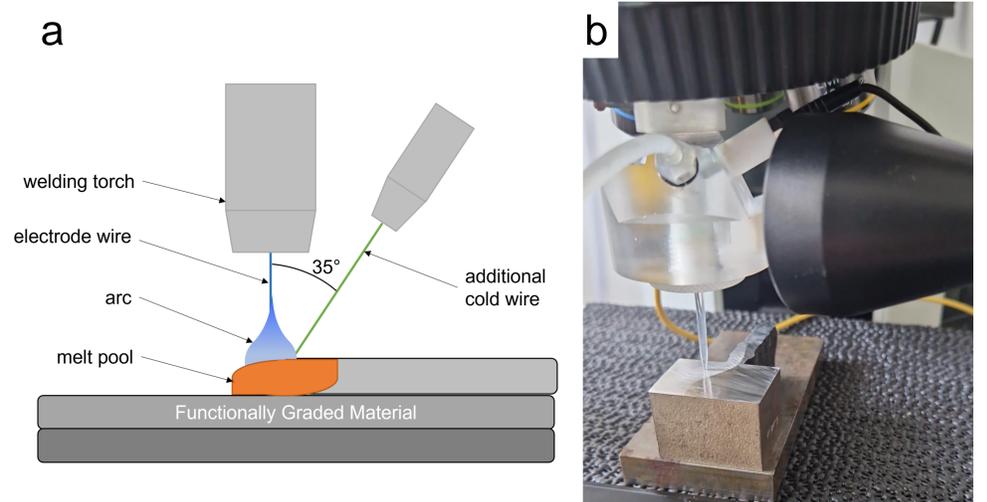
Experimental Setup

a: cold-wire Gas-Metal-Arc-Welding (cw-GMAW)

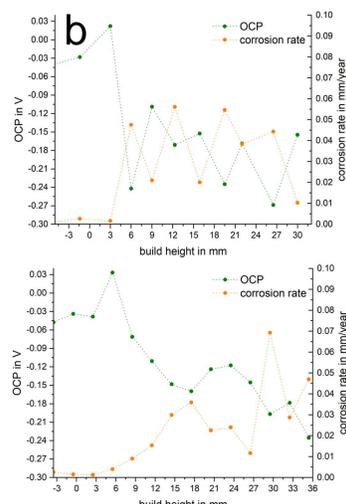
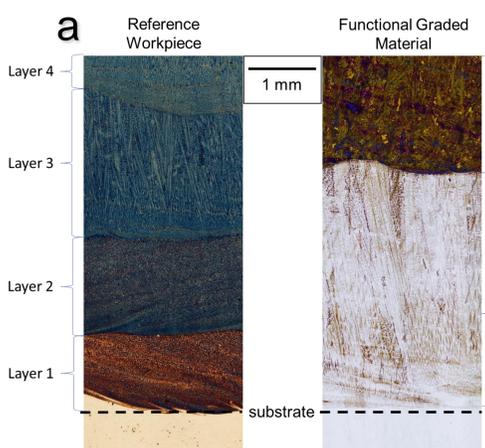
- wire feed rates of 5 m/min and voltage at 17.5 V
- 98% Ar 2% CO₂ shielding gas with 12 l/min flow
- torch movement of 500 mm/min
- contact tube working distance (CTWD) was closed-loop controlled

b: electrochemical cell with workpiece

- measurement area of approximately 0.8 mm²
- 3.5 wt.-% NaCl solution as electrolyte
- A saturated Ag/AgCl electrode was used



Results



a: Microstructures of the initial layers

- reference piece dendritic from layer three
- FGM dendritic from layer one upwards
- higher cooling rates of cw-GMAW responsible

b: OCP and corrosion rate of reference ↑ vs. FGM ↓

- FGM showed 24% lower average corrosion rate
- No intergranular or galvanic corrosion occurred
- For SCC further tests are needed

Publications

Hölscher, L., Hassel, T., Maier, H.J.: *Detection of the contact tube to working distance in wire and arc additive manufacturing*. In: The International Journal of Advanced Manufacturing Technology 120 (2022), 1-2, S. 1042–1053

Hölscher, L., Hassel, T., Maier, H.J.: *Development and evaluation of a closed-loop z-axis control strategy for wire-and-arc-additive manufacturing using the process signal*. In: The International Journal of Advanced Manufacturing Technology 128 (2023), 128 // 3-4, 1725-1739