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Evaluation of liquid tin corrosion on austenitic steels as well as nickel-based alloys and first tests on possible protective surface layers at high temperature

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Statement of the Problem: The application of liquid tin as a process or as a heat transfer medium is limited, mainly due to its corrosive action on typical materials of construction like steels or nickel-based alloys. If the alloys are, however, protected against liquid tin, e.g., by surface layers, they may be employed as construction material.

Aim: The corrosion of liquid tin on austenitic steels and nickel-based alloys at high temperature is evaluated followed by first tests of possible protective surface layers.

Methodology: Corrosion experiments were performed on austenitic steels as well as nickel-based alloys. The alloys were exposed to liquid tin at 500, 700 and 1000°C for 25, 50 and 100 h. The occurring phenomena were analyzed and the associated material loss quantified. Candidate protective layer materials, e.g., carbides, nitrides or oxides, were formed on the alloys by thermochemical and thermophysical processes and their protection against liquid tin evaluated in screening tests at elevated temperatures.

Findings: Both alloy types exhibit selective leaching of nickel and formation of intermetallic compounds in the melt as well as layers on the corrosion scales. The material loss increases with exposure time as wells as testing temperature and is higher in case of the nickel-based alloys than for austenitic steels. In regard to the screening tests of potential protective surface layer materials, carbides and nitrides are stable against the liquid tin. A layer of chromium nitride significantly reduced the corrosion on a steel sample. In case of continuous oxide layers their stability and thus protection against liquid tin increases with layer thickness.

Conclusion: The results show the potential of surface layers to significantly reduce the corrosion of liquid tin. With further development, the layers reliability may be increased thus allowing to utilize liquid tin as a process medium.

Biography

Thomas Emmerich has completed his MSc in Mechanical Engineering with specialization in Material Engineering in 2013. From 2013 to 2016, he completed his PhD in Liquid Metal Corrosion Group at Institute of Applied Materials-Applied Material Physics, Karlsruher Institute of Technology. During his PhD, he analyzed the material related aspects of the thermal decomposition of methane in liquid tin.

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