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Development and Additive Manufacturing of MoNiCr Nickel Alloy for Energy Industry Applications

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One of the investigated concepts for Generation IV nuclear reactors is a molten salt-cooled reactor system. A critical aspect of this concept is the material selected for components of the primary and secondary circuits of the power source, which is exposed to extreme chemical and thermal loading. The loading arises both from aggressive chemical interactions with molten salts at elevated temperatures and from creep stress. Due to the unavailability of specialized materials suitable for this environment, such as the Russian alloy HN80M, the French alloys EM-721 and EM-722, or the Chinese alloy GH3535, a proprietary nickel alloy named MoNiCr has been developed in the Czech Republic.

This work addresses the manufacturing issues related to the MoNiCr alloy, covering conventional casting processes, hot and cold forming into wire form, powder atomization, additive manufacturing (AM), and final heat treatment, including metallographic analyses and mechanical property testing. Final experimental samples were fabricated using Directed-Energy-Deposition (DED) additive manufacturing technology. This modern manufacturing technology was selected due to its capability to produce complex component geometries required in the energy industry, which are often impossible to manufacture using conventional methods.

MoNiCr is a very difficult to form material and is highly susceptible to solidification cracking during additive manufacturing processes. Therefore, considerable attention must be given to the quality of input material for additive manufacturing, whether in powder or wire form. Equally important is the careful selection of process parameters, which has also been extensively addressed in this work.

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