Influence of Magnetic Fields on Dilution during Laser Welding of Aluminium

C. Thomy[a] and F. Vollertsen[b]

BIAS Bremer Institut für angewandte Strahltechnik GmbH,
Klagenfurter Str. 2, D-28359 Bremen, Germany

[a]thomy@bias.de, [b]vollertsen@bias.de

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Abstract. In order to minimize the occurrence of hot-cracking phenomena in laser welding of hot-cracking sensitive aluminum alloy sheets, it is a common technique to introduce silicon-containing filler wire into the weld metal. However, to achieve an optimum result, a homogenous distribution of not less than 2 % of silicon throughout the weld metal is strongly recommendable. Under certain circumstances, this may be a difficult task. One potential solution to achieve sufficient dilution and, consequently, a very homogenous silicon distribution might be the application of alternating magnetic fields. In foundry technology, the use of magnetic fields to influence melt flow is a well-established method. For TIG welding, a process called magnetic stirring was first investigated in the 1970s. It was sufficiently demonstrated by the help of an alternating magnetic field coaxial with the arc axis, that, among other effects, the degree of dilution can be increased and a refined grain structure is achieved. Since the late 1990s, some efforts have been taken to apply constant magnetic fields to laser welding processes. However, neither alternating fields nor potential effects on dilution have been in the focus of these investigations. To help this situation, basic studies on magnetically influencing melt flow during laser welding of aluminum have been conducted. To that end, alternating fields have been coaxially applied with magnetic flux densities up to 60 mT and frequencies in the range of 0 to 20 Hz. It was demonstrated by the help of a specially developed method that, depending on the parameters chosen, such fields are indeed capable of influencing melt flow and weld pool dilution, thus “stirring” the weld metal.