

Content

I. List of figures	III
II. List of tables	XIV
III. List of abbreviations	XV
IV. List of symbols.....	XVI
V. Abstract	XVII
1 Introduction	1
2 State of the art.....	3
2.1 Hybrid welding processes	3
2.1.1 Plasma-MIG hybrid welding process	3
2.1.2 TIG-MIG process	12
2.2 Aluminum and its influence on the automotive industry	15
2.2.1 Aluminum properties and weldability	17
3 Statement of the problem and goals	26
4 Experimental set-up and consumables.....	28
4.1 Equipment	28
4.1.1 Welding sources	29
4.1.2 Linear manipulator	31
4.1.3 Measuring devices.....	32
4.2 Materials	36
4.2.1 Metallography	37
4.2.2 Tensile test	37
4.2.3 Microhardness measurements.....	38
4.2.4 Temperature measurements.....	38
4.2.5 Hydrogen measurements	39
4.2.6 Oxygen, magnesium and silicon measurement in the weld beads. ...	40

5 Methods 41

5.1 Arcs coupling 41

5.2 Influence of the plasma process current and MIG current on the hybrid process 42

5.3 Study of the SuperMIG equipment and the magnetic level compensation43

5.4 Applications of plasma-MIG hybrid process 44

6 Experimental Researchs and Discussions 47

6.1 Coupling between plasma and MIG processes 47

6.1.1 Conclusions 58

6.2 Influence of the welding current on the hybrid process 59

6.2.1 Plasma direct current 59

6.2.2 Plasma alternating current 76

6.2.3 Conclusions 92

6.3 Relevance of MIG and plasma processes on the penetration of the hybrid welding..... 92

6.4 Commercial alternative: SuperMIG 95

6.4.1 Magnetic level compensation..... 96

6.4.2 Conclusions 101

6.5 Application: Aluminum joints EN AW6060-T66 102

6.5.1 Microstructures 102

6.5.2 Mechanical properties 108

6.5.3 Hydrogen measurements..... 115

6.5.4 Conclusions 117

7 Conclusions and Outlook..... 118

8 References 120

9 Appendix..... 125