FIRST STEPS TOWARDS THE HEALABLE ALUMINUM ALLOYS

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The fracture of coarse and elongated iron-rich intermetallic particles or interface decohesion are the main sources of microvoid nucleation in 6xxx series aluminum alloys. Friction Stir Processing (FSP) has proven an excellent method to break, round and homogenize these iron-rich particles, as well as reduce the grain size and porosity. This delays damage nucleation and final coalescence improving the fracture strain of the alloy As a result, FSP increases the fracture strain of the Al alloy while making it also more isotropic [1]. Yet another approach to postpone failure is rising: make healable materials. In polymeric materials, this strategy is already applied at the industrial level. The material then consists of capsules containing a healing agent embedded into the polymeric matrix. During crack propagation the agent is released leading to crack closure [2]. Extension of this strategy to metals requires solving problems such as phase formation, the poor interface between the healing agent and the matrix and the anisotropy in healing potential [3].

In the present work, the issues of the healing agent distribution and its interface with the matrix are solved by FSP. Fine Mg particles are embedded by FSP in an Al6063 matrix. In-situ tensile Scanning Electron Microscopy (SEM) tests showed that, in the presence of these particles, the damage mechanism is changed and under the load have revealed a change of the main void nucleation mechanism, i.e., the new healing particles are broken first while the iron-rich intermetallics remain intact. Then, after a heat treatment corresponding to the healing step no damage could any longer be observed by SEM.

References

[1] *Hannard, F., Castin, S., Maire, E., Mokso, R., Pardoen, T., Simar, A., "Ductilization of aluminium alloy 6056 by friction stir processing", Acta Materialia,* ***Vol. 130****, page 121-136 (2017).*

[2] *White, S.R., Sottos, N.R., Geubelle, P.H., Moore, J.S., Ressler, M.R., Sriram, S.R., Brown, E.N., Viswanathan, S., "Autonomic healing of polymer composites", Nature,* ***Vol. 409****, page 794-979 (2001).*

[3] *Rohatgi, P.K., "Al-shape memory alloy self-healing metal matrix composite", Materials Science and Engineering A,* ***Vol 619,*** *page 73-76 (2014).*