Lightweight construction via tailored microstructure of light metals

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The continuous effort in increasing energy efficiency of transport vehicles, building structures or energy conversion devices results in growing role of lightweight construction, which creates great challenges also for material science community.

Light metals based on aluminium and magnesium are still hot candidates for this purpose thanks to their unique combination of low density, high strength, stiffness, fracture toughness and excellent corrosion resistance. There are still many possibilities to improve their properties, most of them are based on alloying followed by proper thermal treatment or by making composites. However there is usually a tradeoff between strength, plasticity and corrosion resistance, where improvement of one property leads to reduction of another one. Moreover the use of standard strengthening approaches based on precipitation hardening is limited by low structural stability at elevated temperatures, due to favorable diffusion conditions and inevitable microstructural changes.

Most of these drawbacks can be avoided using alternative strengthening approaches based on proper tailoring of microstructure of light metals without excessive use of alloying elements or strengthening additives. The effect of different technological methods providing variable microstructures of the identical material on its mechanical properties will be presented. It will be particularly demonstrated on aluminium powder compacts[1] and aluminium foamed parts[2]. Their microstructure usually includes a small portion of aluminium oxides coming from the surfaces of initial powders and pores. The distribution and morphology of oxides, grain size and porosity exhibit a decisive influence on the mechanical properties. Remarkable improvement of the material performance in many applications can be thus achieved. Successful application cases including engine pistons with excellent creep resistance and structural parts with enhanced stiffness and crashworthiness will be presented.

[1] M. Balog, F. Simancik, M. Walcher, W. Rajner, C. Poletti, Mater. Sci. Eng., A 529 (2011) 131– 137.
[2] F. Simancik, W. Rajner, R. Laag, Alulight – Aluminum foam for lightweight construction. In SAE Technical Paper Series 2000-01-0337. Warrendale: SAE, Inc., 2000, p. 31-38.