24. International Forging Congress

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Scientific line:

New materials in forging

Title: Design and selection of suitable Fe-Mn-Al-C low-density forging steels for massive components

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The speaker is senior researcher at SIDENOR, a long product special steelmaker located in north Spain, supplying to automotive and energy markets. Physicist and industrial engineer, he has working in R&D activities for more than 25 years in the field of design and characterization of engineering steels, fatigue and groundbreaking steels and technologies.

Abstract:

The decarbonization of the automotive sector is a key goal to limit the greenhouse effect emissions and attain the Paris Agreement objectives. Besides electrification, the reduction of weight is essential to minimize gases of internal combustion engines and to extend autonomy of electric vehicles. 1 kg of reduction of the vehicle mass leads to avoid 48 kg CO2 emissions along its service life. Fe-C-Mn-Al steels may achieve a 15% diminution of steel density depending on the aluminum content. Considering the strength range of the subfamilies austenitic and austenitic-based duplex, this Fe-Mn-Al-C steels offer a great potential to reduce the weight of transmission and suspension forged components and, subsequently, save fuel and/or electricity consumption and related CO2 emissions.

At the RFCS-funded LIGHTFORGE project, research has been focused on the design and selection of the Fe-C-Mn-Al low-density steels suitable for semi-industrial forging trials of massive components. A detailed description of the encountered drawbacks during casting and forging and the countermeasures taken to overcome them is described. The design of low-density steels was assisted by MatCalc and JMatPro software to select the chemical compositions of laboratory medium-scale ingots. Casting and hot forging/rolling processes were optimized by a sort of trial and error to overcome unexpected obstacles. The characterization of the microstructure by LOM, SEM and synchrotron and the evaluation of its hot ductility allowed estimating the most important features to improve steel processability. Main recommendations include to ensure a microstructure 100% austenitic and to avoid intergranular κ-carbide precipitation by a proper Al-C balance, to use a hot deformation rate as low as possible and to minimize the thermal losses during hot forming.