Ferritic stainless steel with enhanced formability for exhaust systems of hybrid and plug-in hybrid vehicles

Name of member: POSCO
Manufacturer: Sejong
Field: automotive, transport
Location: Korea, China, EU, USA
Environment: urban, rural, industrial
Grade and surface: STS439 (Poss439XF) / 2B
Competing material: austenitic stainless steel
Advantage point of using stainless steel:
The complex and compact exhaust parts of increasing eco-friendly hybrid and plug-in hybrid vehicles in the near term can be fabricated by virtue of excellent formability of the developed ferritic grade.

Governments around the world are seeking ways to reduce oil use and green gas emissions by strengthening regulatory efficiency standards. Automotive companies are deploying various passenger vehicles with advanced internal combustion engines and fuel-efficient hybrid powertrains to meet lower emission levels.
The hybrid powertrains normally consist of an efficient combustion engine and an electric driving unit of motors and battery modules. Since two driving units are installed on a vehicle, the spaces for exhaust parts are going to be limited and the shapes of exhaust parts of hybrid vehicles tend to be compact and complex. Moreover, the demand of lightweight exhaust parts guaranteeing longer lifetime would result in the selection of high chromium stainless steel as a preferred material. POSCO has developed the cutting edge fabrication technology over the years to maximize the formability of high chromium content ferritic stainless steels. By developing innovative oxide-metallurgy technologies during the steel making process and advanced texture-control engineering, extra formable ferritic stainless steel has been commercialized. The controlled equiaxed grain structure in slabs is one of outstanding technical achievements, which is the prerequisite to make extra formable materials. The refinement of grain structures in slabs by the oxide-metallurgy can be achieved even without the usage of EMS (Electro Magnetic Stirrer) in continuous casting and this could reduce the investment cost of construction of new manufacturing facilities.
The deep drawing property of the developed material is elevated 20~30% higher than conventional ferritic grades. The 180 degree bending of pipes made with conventional and new developed ferritic stainless steels show clearly the benefit of the enhanced formality. The wrinkling defect during bending is diminished by adopting the developed material. The

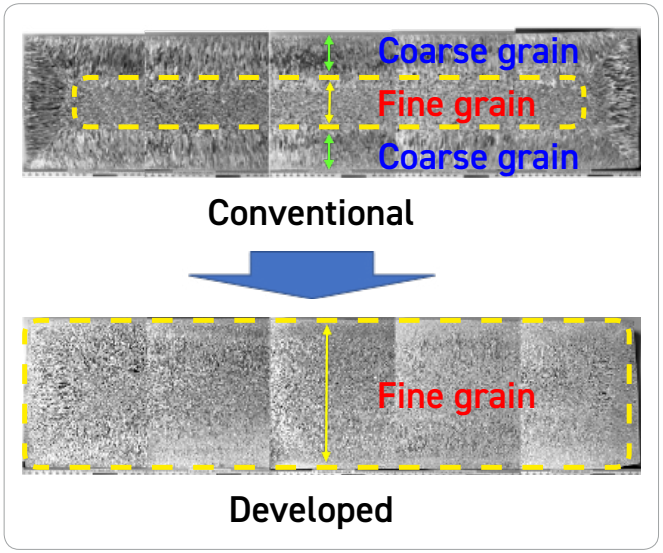

Figure 1: Comparison of conventional and developed slab grain structures
Picture courtesy of POSCO

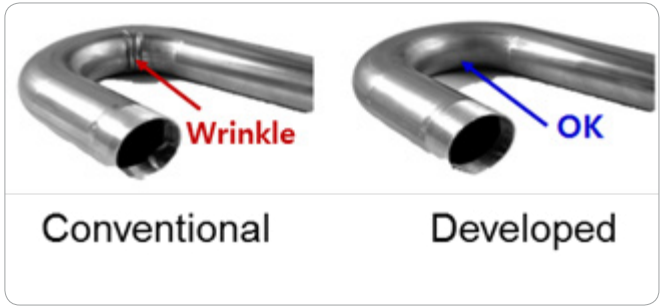

Figure 2: Pipe bending with conventional and developed ferritic stainless steels
Picture courtesy of POSCO

deep drawing stamping of muffler caps in exhaust parts of a compact-sized vehicle demonstrates that necking fracture by thickness reduction in the deformed part is reduced negligibly as a result of the excellent formality. In addition, more uniform thickness distribution in the deformed part allows to make it thinner and lightweight.

The other distinguished property of the developed material is the excellent mechanical toughness in the welding zone. The TIG welded zone of the developed material shows finer grain structures than conventional ferritic grades. This contributes to the improvement of ductility in the welded zone and then reduces cracks and tearing near the welded zone in the subsequent forming operations after welding. Lastly, enhanced formability can be further utilized in deep drawing applications in other industries.

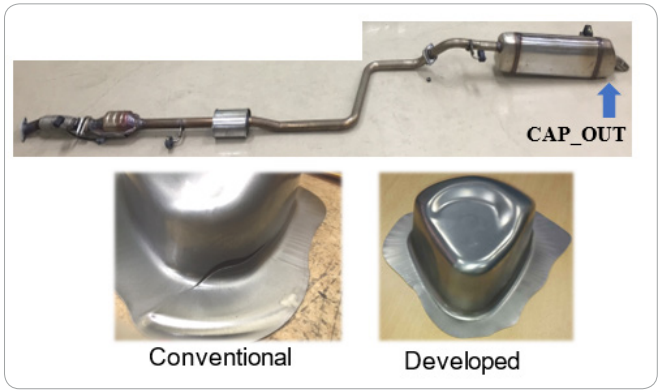

Figure 3: Stamping trials of muffler caps with conventional and developed ferritic stainless steels
Picture courtesy of POSCO

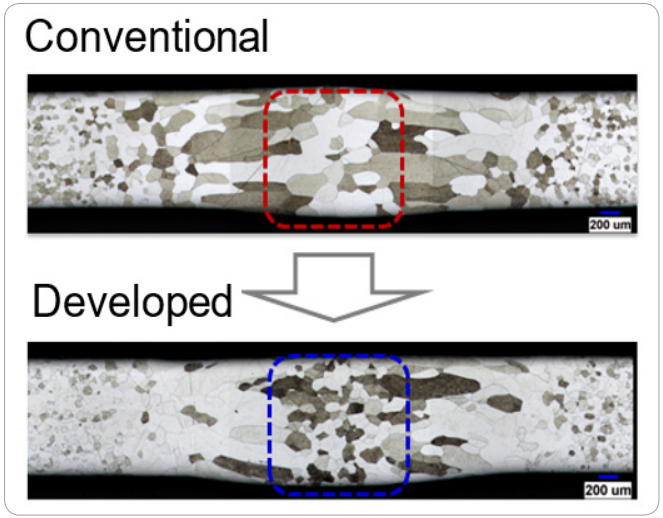

Figure 4: Comparison of weld-zone grain structures between conventional and developed ferritic stainless steels
Picture courtesy of POSCO