Abstract of Main Thesis

Study on Harmonic Structure Design and Deformation Mechanism in SUS304L Austenitic Stainless Steel

ちょう　ちぇ
ZHANG Zhe

Grain refining is a well known method of strengthening structural materials. However, ultrafine-grained materials are characterized by low tensile ductility because of plastic strain instability in the early stage of deformation. “Harmonic structure designed” material produced by mechanical milling and powder metallurgy method is proposed to overcome this drawback. However, the harmonic-structure austenitic stainless steel has not been carried out, and its deformation and fracture mechanism have not revealed yet. Therefore, the present thesis describes the work on a better understanding of the manufacture, mechanical properties, deformation and fracture mechanism of harmonic-structured austenitic stainless steel.

Water-atomization is the most common technique for producing low-cost metal powders. However, a large amount of SiO_2 particles precipitate in the sintered water-atomized SUS304L compacts owing to the high oxygen content in initial powders, which impair the bonding and result in poor ductility.

The harmonic-structured SUS304L stainless steels have been achieved in the sintered compacts using “clean and spherical” PREPed powders, which demonstrate a winning combination of improved strength and ductility as compared to their coarse-grained and ultrafine-grained counterparts.

Through comparing the tensile deformation of the specimens having different bimodal structure heterogeneity and topology, it is concluded that the three-dimensional continuous connected network of UFG structure is conducive to restraining stress concentration in tension, which leads to postpone the plastic strain instability. Therefore, the tensile ductility, in particular uniform elongation of harmonic-structured SUS304L steels is superior to that of bimodal structured ones having irregular spatial distribution of CG and UFG. Furthermore, the deformation and fracture mechanism of harmonic-structured SUS304L are also discussed.