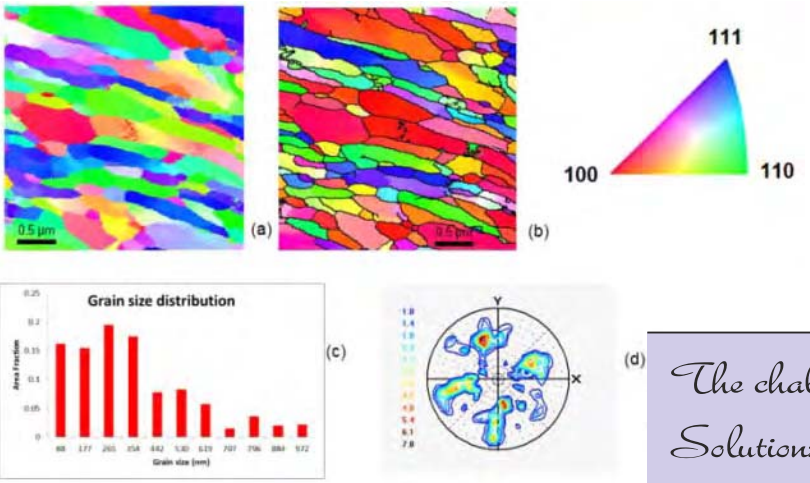
Orientation mapping in TRIP steels reveal their texture and help to understand their properties

Better Steels with Improved Properties

Steel is an alloy made by combining principally iron and carbon, moreover other alloying elements are used to improve mechanical characteristics, such as manganese, or vanadium. The resulting steels are commonly know as High Strength Low alloy Steels (HSLA).

Carbon and other elements act as a hardening agent, preventing dislocations in the iron atom crystal lattice from sliding past one another. Varying the amount of alloying elements and the form of their presence in the steel (solute elements, precipitated phase) controls qualities such as the hardness, ductility, and tensile strength of the resulting steel. To harden a material, and especially a ferritic steel, it is also important to control the grain size, through cold rolling and recrystallisation processes.




James Bond car

The challenge: Identify orientation in deformed steels to measure grain size, and identify martensitic phases in stainless steels

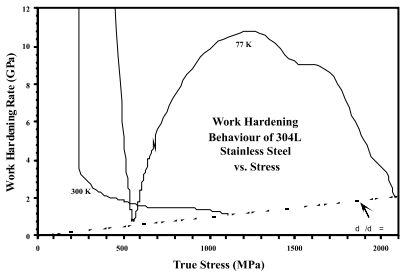
Solution: ASTAR technique coupled with precession electron diffraction

figure 1

Grain refinement analysis in severely deformed pure iron. Orientation map with the color related to (a) x axis, (b) z axis with grain boundaries highlighted, (c) grain size distribution and (d) {111} pole figure. The color code for the orientation maps is shown on the right


Liege-Guillemins railway station, Belgium

In metallurgy, stainless steel, also known as inox steel, is defined as a steel alloy with a minimum of 11% chromium content by mass.Stainless steel does not readily corrode, rust or stain with water as ordinary steel does. There are different grades and surface finishes of stainless steel to suit the environment the alloy must endure. Stainless steel is used where both the properties of steel and resistance to corrosion are required. Some austenitic stainless steels have the spectacular property to transform into martensite when deformed, providing a unique combination of very high strength and ductility.



During deformation in tension, martensitic phases are formed in austenite, giving rise to a spectacular work hardening effect. Phases are clearly seen and characterized with ASTAR.

Crystal Structure

Ferrite: cubic, a = 2.86 Å
Austenite: cubic, a = 3.59 Å
ε-martensite: hcp
Martensite: Cubic, a= 2.86 Å

Experimental Data

TEM type: CM 200
Map resolution: 10 nm
Scanned area: 5 x 5 µm

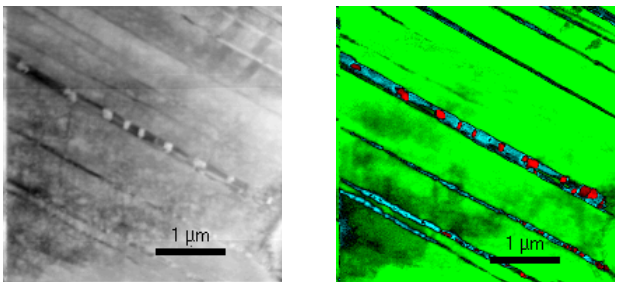


figure 2

TRIP 304 steel : Green = austenite fcc, Blue = e- martensite, red = martensite.

Courtesy Dr. A. Gholinia , Manchester University UK
K. Spencer, M. Veron et al *Materials Science and Engineering A* 387-389 (2004)