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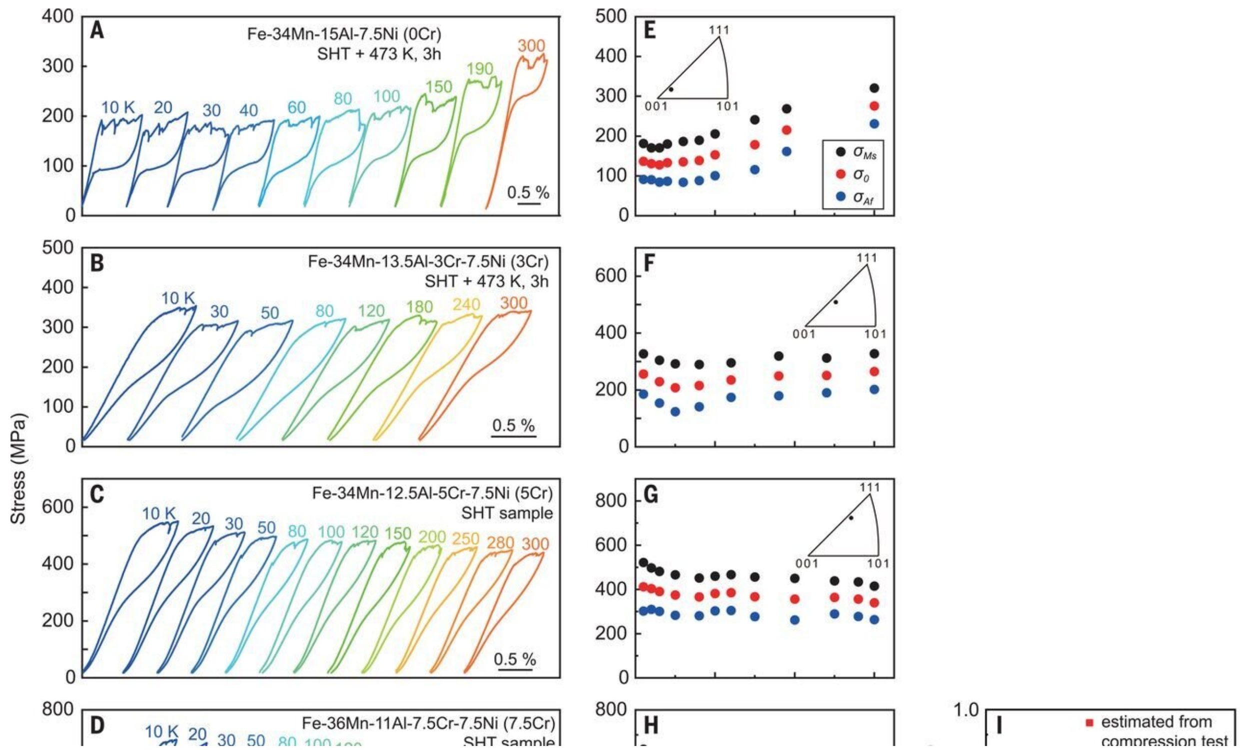
A superelastic alloy with a nearly limitless temperature window

August 14 2020, by Bob Yirka



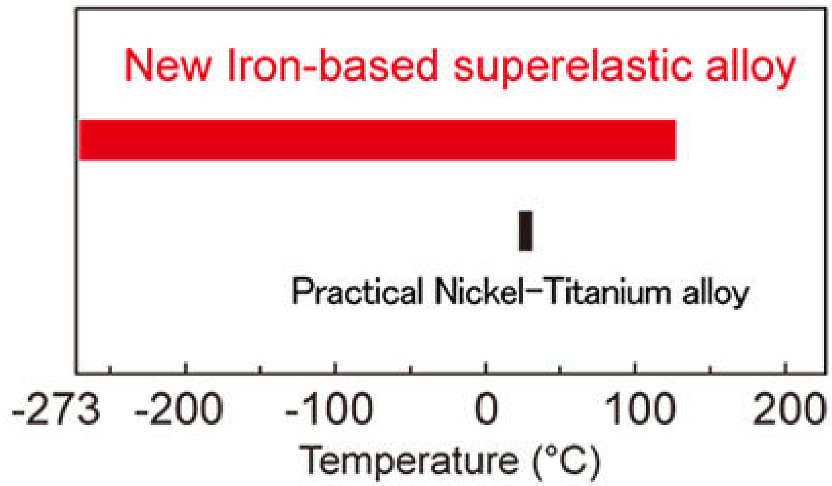
Mechanical properties of Fe-Mn-Al-Cr-Ni shape memory alloy system. Credit: *Science* (2020). DOI: 10.1126/science.abc1590

A team of researchers at Tohoku University has developed a new kind of superelastic alloy with a nearly limitless superelastic window. In their paper published in the journal *Science*, the group describes the new alloy's properties and possible uses for it. Paulo La Roca and Marcos

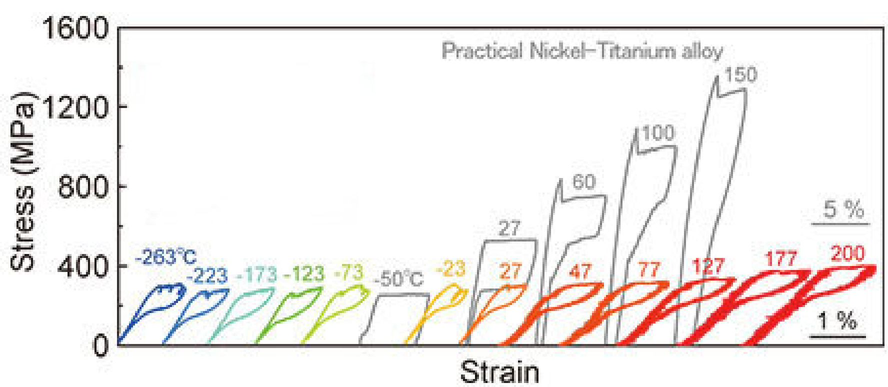
Sade with Universidad Nacional de Cuyo–CNEA have published a Perspective piece in the same journal issue outlining the state of bendable alloys and the work done by the team in Japan.

Most metals in everyday use can bend somewhat. To get them to return to their original shape generally requires force such as from a hammer. Superelastic alloys (also known as metals with shape memory) can be bent with up to 20 percent deformations and will return to their original shape automatically. La Roca and Sade note that superelasticity in metals can be explained by the presence of stress-induced martensitic transformations. But there is a caveat for such alloys—they can only rebound back to their original shape when they are in a certain range of temperatures: their superelastic window.

Unfortunately, most such windows are quite small, limiting the use of superelastic metals in practical applications. Scientists would like to discover alloys that can be used in wider temperature variations for use in applications such as space science (because of the temperature extremes). In this new effort, the researchers have found just such an alloy—one with a nearly limitless superelastic window. During testing, its superelastic window was found to be 10 to 473 K (-263 C° to 200 C°), making it applicable in virtually all natural settings. The researchers note that the alloy was also found to have very low thermal expansion.



The temperature range of the new iron-based SEA compared to conventional metal-based SEAs for a stress change of 50 MPa. Credit: Tohoku University



A comparison of the stress-strain curves of the new iron-based SEA in comparison to Nickel-Titanium alloy. Credit: Tohoku University

The team created the alloy by adding chromium to a Fe-Mn-Al-Ni alloy. In so doing, they also showed that entropy change is controllable using this approach. The entropy change for the new alloy was tested to be very near zero. The researchers also note that the alloy is tunable by varying the amount of chromium, which highlights the fact that the team actually created a host of superelastic "invar" alloys.

More information: J. Xia el al., "Iron-based superelastic alloys with near-constant critical stress temperature dependence," *Science* (2020). science.sciencemag.org/cgi/doi … 1126/science.abc1590