Japanese material scientists develop new superelastic alloy

July 1 2011, by Bob Yirka

(PhysOrg.com) -- Working out of Tokyo University, scientists in the Department of Materials Science, have developed a new metal alloy that unlike other "superelastic" alloys can resume its original shape in temperatures ranging from -196 to 249 degrees Celsius. Prior to this discovery, such alloys were only able to revert to their original form in the much narrower range of -20 to 80 degrees Celsius. They have published their findings in the journal *Science*.

Superelastic alloys are metals that revert naturally back to their original shape after being bent or deformed by outside forces once those forces are removed, and are generally created by mixing two or more other metals together in certain combinations.

In this new effort, the research team added a small amount of nickel to an iron based alloy, which according to lead author Toshihiro Omori, in an email interview with Reuters, says makes their product far more elastic than anything else out there. He also said that because the ingredients for the new metal are plentiful, the resultant alloy should be very cheap to produce.

The reason that superelastic allows are able to revert to their prior shape is due to their unique crystal structure that allows all of the atoms it's made of to shift as one when a force is applied, as opposed to normal metals where the force is diffused through the crystal structure changing it's composition.

Superelastic alloys are used in many applications such as eyeglasses, antennas, and medical tools and equipment. Omori, says he hopes that this new alloy, because of its ability to revert in virtually any real world temperature conditions, can be used in buildings to protect against earthquake damage, or in other applications where things get hot under stress, such as in cars, airplanes and spacecraft.

Because many tall buildings are supported by metal beams, the thinking goes, if the those metal beams were made of a superelastic alloy, they would be able to snap back to their original positions after each gyration of the ground, rather than suffering compound trauma as the quake continues, making it much less likely that the building would crumble or fall.

More information: Superelastic Effect in Polycrystalline Ferrous Alloys, *Science* 1 July 2011: Vol. 333 no. 6038 pp. 68-71. DOI:10.1126/science.1202232

ABSTRACT
In superelastic alloys, large deformation can revert to a memorized shape after removing the stress. However, the stress increases with increasing temperature, which limits the practical use over a wide temperature range. Polycrystalline Fe-Mn-Al-Ni shape memory alloys show a small temperature dependence of the superelastic stress because of a small transformation entropy change brought about by a magnetic contribution to the Gibbs energies. For one alloy composition, the superelastic stress varies by 0.53 megapascal/°C over a temperature range from –196 to 240°C.