EN1102

APAM Module

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Wires gain mechanical strength through *cold-working*. In the process of manufacturing wires, the wires are drawn through ever-smaller apertures and deformed plastically (irreversibly), reducing their diameter. The process of drawing the wire generates crystalline defects (dislocations): permanent deformation of metals usually implies that dislocations have started to move irreversibly, and have started to multiply.

The more easily dislocations can move, the lower the yield stress of a metal will be. Crystalline defects impede the motion of dislocations. After being deformed permanently, the metal's yield point tends to rise—the metal has been strengthened.

Guitar strings which ship to us for use have already been wire-drawn in manufacturing, and have already been strengthened. It is possible to remove some of the crystalline defects (dislocations in this case) by heat-treatment, or annealing. Atoms would like to find their lowest-energy configurations, which for many metals is the close-packed configuration, but they need a little thermal energy to be able to move around—at room temperature, disorder is "frozen in." Typically, rapid-enough atomic motion has an onset around 0.6 Tm, where Tm is the melting point in degrees C.

Modified guitar strings: A subset of the high E-strings have been *heat-treated.* These are steel strings, 0.25 mm diameter, D'Addario brand. We (Vlad) heated these in air between 607-645 deg. C for 5-6 minutes prior to class. The melting point of steel is around 1370 C. What do you think this will do to the Young's modulus? To the yield point? To the ductility?

Test whether the string has been strengthened or weakened, and monitor the effect on all these properties. In your writeup, justify your results. N.b. the string looks a little discolored—what does this tell you, and what complication might this introduce?