[SQUEAKING] [RUSTLING] [CLICKING]

ISAAC METCALF: In this video, we'll be discussing Goodie Bag 7, or crystalline defects. The objectives are to visualize zero dimensional, one dimensional, and two dimensional defects in crystalline materials. You'll need a double-sided strip of adhesive, two Plexiglas panels, and 500 1/16th-inch metal beads.

First, pull off the protective film on the top of your acrylic sheet. Take four pieces of double-sided tape and put one piece on each of the edges of the acrylic sheet. Then carefully put your balls in the middle of the square made by the four pieces of tape. Finally remove the film on the top of the other acrylic sheet and put it on top. When you're finished, you should have a completed defect modeling kit.

CAROLYN JONS: Now that you've built your model, let's use it to visualize how material processing impacts the number of defects visible in a crystal. When looking at our original crystal, you can see several defects. These are a vacancy, line defect, and grain boundary defect. Material processing can lead to both increases and decreases in the number of defects in the material.

A process that leads to an increased number of defects is extrusion or rolling, because when we extrude or roll a material, we force the atoms to go into certain places and those aren't necessarily the most energetically favorable states. Let's look at our model to understand how material processing leads to an increased number of defects. When we shake the model, we're able to add defects to the system. As you can see now, our model has an increased number of vacancies, line defects, and grain boundary defects.

Other material processing methods allow for a decrease in the number of vacancies. One possibility for this is annealing. When we anneal, we heat the material up, and then we cool it slowly and allow the atoms to move back to their more favorable states. To illustrate annealing, let's tap gently on the side of our model. As you can see, the number of defects in our material has been substantially reduced.

In this Goodie Bag, we were able to visualize some of the defects seen in many crystals, and we were also able to see how processing conditions impact the number of defects in a crystal.