Nano-Mechanics at LANL

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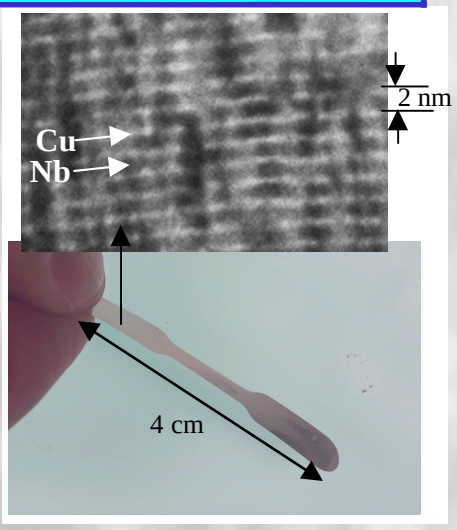
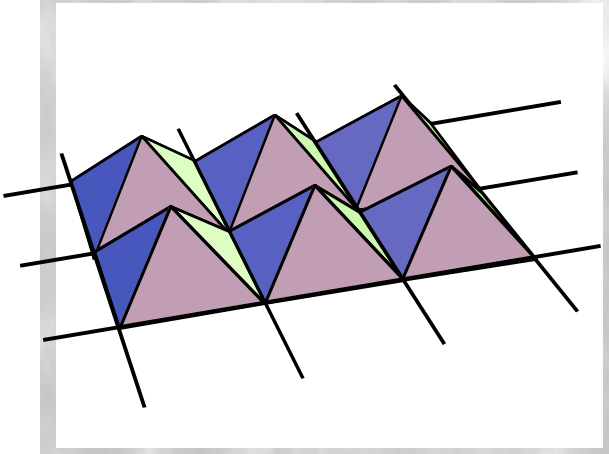
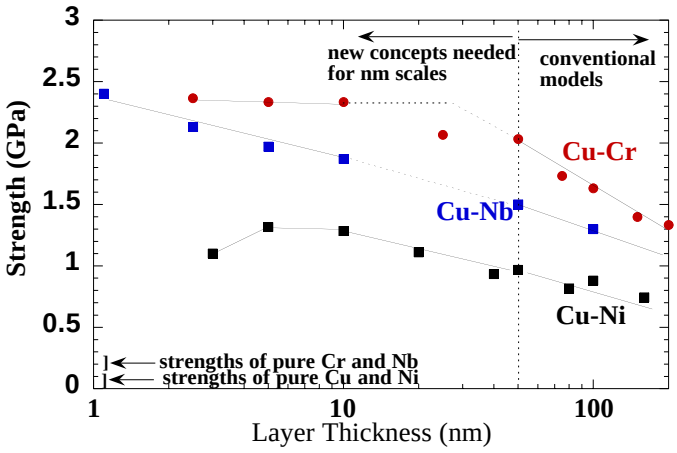
Atom-by-atom deposition of different metals into many very thin layers opens the door to the creation of a new realm of composite materials with incomparable levels of strength and toughness. The test sample shown here consists of thousands of alternating layers of copper and niobium. Each layer has a thickness of only a few nanometers. At these nanometer-scale layer thicknesses, the material deforms in ways that are very different from that of conventional materials. **The research at LANL is involved in the exploration of new concepts in the physics of strengthening of ultrafine scale materials**.





Our program incorporates atomic scale computer modelling as an integral companion to experiment to understand why these very thin layered structures are so strong. The atomic scale models are capable of revealing intimate details that are difficult to see in microscopes or by other types of experimental methods. This array of pyramids was suggested by atomic simulation models as a possible structure of Cu/Ni interfaces and consists of a combination of defects known as stair rods and stacking faults. The computer models also indicate that this structure is very resistant to deformation.

Very high strength derives from fine scale. Composites of nanolayered metals can achieve strength levels that are 100 to 1000 times greater than the conventional strength of the individual components. **Nano-scale design shows promise of synthesizing the strongest metals ever known to mankind.** This graph shows how strength depends on layer thickness in several different combinations of layered composites. We see that in some cases, but not all, the strength tends to reach a maximum. **The research at LANL is aimed at developing an understanding of the origins of this behavior so that materials can be tailored to reach even higher strength levels.**



Strength (estimated as hardness divided by 3) vs.the layer thickness of several Cu-based multilayers. Note the significant increase in strength as compared to strengths of pure metals (estimated at 10 μm grain size).