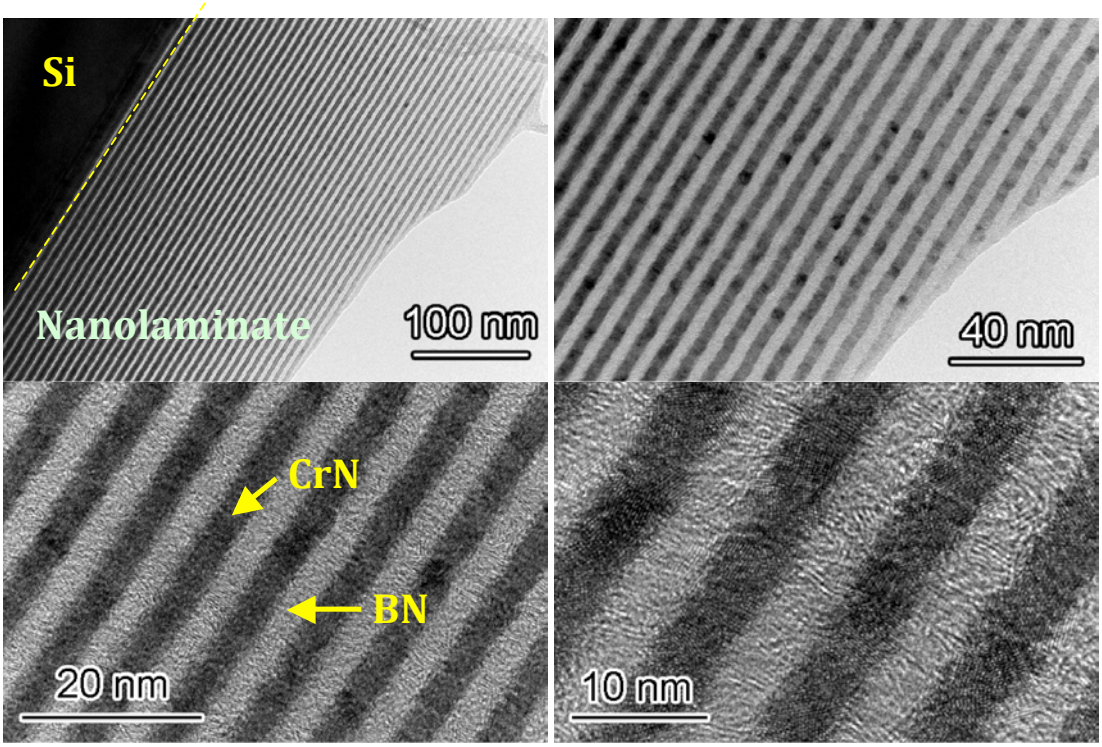
SCIENTIFIC ACCOMPLISHMENTS: NANOLAMINATE STRUCTURES FOR HYDROGEN WEAR RESISTANCE

Nanolaminate Films for Hydrogen

Hydrogen is a clean energy source for the future but it also acts to degrade many metals and alloys through hydrogen embrittlement. A solution to this problem is the design of materials that are both insensitive to hydrogen and can protect underlying metals to hydrogen permeation and embrittlement. One particular area of concern is the enhanced wear of normally wear-resistant steels in hydrogen due to embrittlement. Ultra-hard nanolaminate films can act to protect the steels to hydrogen ingress and can provide additional wear resistance in hydrogen atmospheres. Alternating layers of chromium nitride and boron nitride are deposited onto a silicon substrate for wear testing and other analysis. The two nitrides are thought to be rather insensitive to hydrogen due to strong covalent bonding and the lack of stable chromium or boron hydride phases. Together the two hard materials make a film that is stable in hydrogen and one that is harder than either material alone. Wear tests in hydrogen have corroborated these initial hypotheses. Tests are underway to further explore these materials and their ability to block hydrogen from steels.



The images are electron microscope pictures of these fine-scale films or nanolaminates. The dark layers are CrN and the light layers are BN. They are deposited in alternating layers using sputter deposition in nitrogen. The layered structure provides additional strength to the individual layers and also provides a more tortuous path for hydrogen diffusion.

JV Ryan, CH Henager, Jr., and WD Bennett, in preparation and to be submitted to J. American Ceramic Society (2009).

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