Low Temperature Annealing Effects on Magnetron Sputtered Al/Ni(V) Reactive Coatings

Cadet Nicholas A. Soroka
United States Military Academy
West Point, New York

Matthew P. Blickley
The Pennsylvania State University
College Park, Pennsylvania

ARL Sponsor: Dr. John Derek Demaree and Dr. James K. Hirvonen
Weapons and Materials Research Directorate
U.S. Army Research Laboratory
Aberdeen Proving Grounds, MD

ABSTRACT:

Recently, the Army has been investigating the integration of bimetallic, nanolaminate foils into composite structures for the controlled debonding of adhesive joints. For safe and reliable use, one must be able to characterize and manipulate the properties of these reactive foils. This project focused on the characterization of nickel(vanadium) / aluminum multilayer structures which had been deposited by magnetron sputtering onto a carbon composite substrate. The 300-bilayer samples (each bilayer approximately 140 nm thick) were characterized for their ignition sensitivity to various sources. An electrical spark was found to be a reliable means of propagating the reaction and so was investigated further.

Thermal annealing in air at various temperatures and durations provided a way to significantly alter the initiation sensitivity of the reactive foils to spark ignition. It is thought that this is a result of interdiffusion along grain boundaries and the formation of the metastable Al9Ni2 phase, in agreement with previous studies. These mechanisms were confirmed using Rutherford Backscattering Spectrometry (RBS) for both single bilayer samples and the 300 bilayer samples. Such studies also allow us to predict the useful lifetime of such debonding systems in the high-temperature environments they may encounter when deployed.

KEYWORDS: nanofoils, nanolaminate, vacuum coating, Al/Ni(V), thermal annealing, initiation energy, initiation sensitivity, debonding

CONTACT: Matthew P. Blickley, The Pennsylvania State University, College Park, Pennsylvania, Tel: 814-862-7343, Email: mpb5005@psu.edu

J. Derek Demaree, Weapons and Materials Research Directorate, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD 21005-5069, Tel: 410-306-0840, Email: jdemaree@arl.army.mil.

James K. Hirvonen, Weapons and Materials Research Directorate, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD 21005-5069, Tel: 410-306-0870, Email: hirvonen@arl.army.mil.