Final Report for AASERT Program N00014-97-1-0557, "Nondestructive Three-Dimensional Microtexture/Strain Quantification in Al-Li 2090."

Stuart R. Stock  
Professor  
School of Materials Science and Engineering  
Georgia Institute of Technology  
Atlanta, Georgia 30332-0245

DISTRIBUTION STATEMENT A  
Approved for Public Release  
Distribution Unlimited

Results

The AASERT program was to fund one graduate student and one undergraduate student. The emphasis was on interpretation of microtexture's role in crack deflection in Al-Li 2090; this allowed the parent program to devote more effort to strain measurements. Research focused on material just ahead of the crack tip and on how the fatigue crack "plane" develops under the influence of microtexture; understanding of microtexture is also essential to interpretation of the strain/stress measurements conducted in the parent program. In order to study these aspects of crack propagation, a new method of microtexture tomography, with spatial resolution approaching that of optical microscopy, was developed utilizing microbeam synchrotron diffraction.

Research employed synchrotron polychromatic microbeams to map microtexture in three-dimensions in Al-Li 2090. The results expanded on earlier observations and are communicated in the publications tabulated below. Also of considerable interest was the demonstration that the synchrotron microbeams could produce transmission Laue patterns in reasonable times through 2-3 mm thicknesses of Ti-6Al-4V; this means that the techniques developed in this program will have much greater use in materials of interest to ONR.

Six invited presentations were given, two MS theses were defended successfully and 13 papers appeared (two in Acta Materiala, one in Philosophical Transactions of the Royal Society (London) and one in an ASTM STP. One paper is in press, two others have been submitted and several additional papers will be submitted in the future.

Student’s Supported and Project Participants’ Accomplishments

The following US citizens’ graduate work was supported by this program: J.D. Haase, R. Morano. Their theses are listed below. A third MS thesis student, C.R. Patterson II who was supported by the predecessor AASERT grant, finished his thesis during the course of this program. The following US citizens served as undergraduate research assistants on this program: Chekesha Bradford, Tony Watt, Jennifer Hayes and Kimberley Smith. Patterson and Bradford are Afro-American.
The students who were supported on this program achieved significant recognition. Ms. Bradford won a NSF Graduate Fellowship, which she declined, and a DOD Graduate Fellowship, which she accepted. Mr. Haase won the 1998 Georgia Tech Sigma Xi Outstanding MS Thesis Research Award. Finally the project director, Dr. S.R. Stock, was promoted to Professor from Associate Professor in 1999.

Books written or edited by the Project Director:


Publications:


Invited presentations:

Theses:
Nondestructive Three-dimensional Microtextural Strain in Quantification in Al-Li 2090

Micro- and meso-textures' roles in defining fatigue crack path in Al-Li 2090 TBE41 compact tension samples was the central focus of the research. Near-single crystal volumes up to 0.4 mm x 1 mm x 2 mm, i.e., stacks of five or more adjacent, pancake-shaped grains, comprise over 40% of the center portions of 2090 plates; two other Al alloys showed little to no near-single crystal volumes. The synchrotron microbeam diffraction techniques (polychromatic x-radiation) developed in this research were also found to be useful in heavily-deformed copper and in Ti-6Al-4V samples.