15. 6–4 X-RAY STRUCTURAL STUDIES OF THIN AMORPHOUS FILMS ON SUBSTRATES*. By A. Fischer-Colbrie, Materials Science Dept., Stanford Univ., Stanford CA, 94305 and P.H. Fuoss, AT&T Bell Laboratories, Holmdel NJ, 07733 USA

The grazing incidence scattering (GIS) technique has been developed for studying the structures of thin amorphous films on substrates with x-ray synchrotron radiation. In this technique, the penetration depth into the sample can be continuously varied from 25 Å to bulk thicknesses by controlling the grazing incident angle of the highly collimated beam. Radial distribution functions (RDF's) from amorphous layers as thin as 250 Å were obtained with a few hours of data collection. Exploiting the energy tunability of synchrotron radiation, differential anomalous scattering (DAS) and EXAFS measurements in this surface sensitive geometry were performed. The method was applied to a-Ag-$GeSe_2$ films in which the Ag was incorporated by photodiffusion. These studies will be presented, as will be investigations of the minimum film thickness which can be easily studied, the degree to which the signal from the surface can be enhanced by controlling the incident angle, and the depth sensitivity.

*Work supported by the NSF and by the DoE through the Stanford Synchrotron Radiation Laboratory.

15. 6–5 NANOSECOND TIME-RESOLVED DIFFRACTION STUDY OF LASER EXCITED $5d^1$ STATE IN CeP_5O_{14}. By D.Pruss*, G.Huber*, H.G.Danielmeyer*, H.D. Bartunik**, *Univ.Hamburg, Inst.Angew. Physik, Hamburg, FRG; **EMBL c/o DESY, Hamburg, FRG.

A short-lived $4f^o5d^1$ excited state (τ=18.6 nsec) in a CeP_5O_{14} single crystal has been investigated by means of a stroboscopic X-ray diffraction technique based on the pulsed time structure of synchrotron radiation (SR) from DORIS running in single-bunch mode. The rocking curve of the (020) reflection of the monoclinic ($P2_1$) structure has been measured with a time resolution of 20 nsec before, during and after laser pulse excitation of CeP_5O_{14} at 307 nm by a Xe*Cl excimer laser on the double-focussing SR instrument X31 (DORIS/HASYLAB). At maximum inversion (reaching ca. 80% population of the excited $4f^o5d^1$ state), the time-resolved rocking curve (Fig.1- Curve C is corrected for effects of population and heating) is shifted to higher Bragg angles as compared to the initial rocking curve without laser excitation. 80 nsec later, the rocking curve is shifted to lower Bragg angles. These observations are interpreted in terms of a superposition of two effects, a decrease by 0.04 Å in the ionic radius of Ce^{3+} in its $4f^o5d^1$ excited state as compared to the $4f^1d^o$ ground state, which causes a contraction of the lattice on the time scale of τ, and a lattice expansion due to heating of the sample to ca. 150K by the laser pulse. Thermal relaxation of the lattice occurs on a msec time scale.

The techniques used in nanosecond time-resolved crystallography are described. Future developments are discussed on the basis of the experimental results.

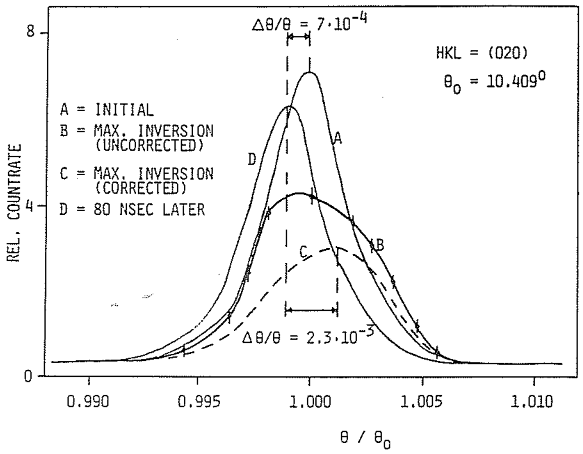

Fig.1

15. 6–6 NANOSECOND RESOLUTION X-RAY STUDY OF SI AND GE DURING PULSED LASER IRRADIATION.* By B. C. Larson, J. Z. Tischler, C. W. White, and T. S. Noggle, Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennesseee 37830 USA, and D. M. Mills, Cornell High Energy Synchrotron and School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14850 USA.

The time structure of the Cornell High Energy Synchrotron Source (CHESS) has been used to make nanosecond resolution time-resolved x-ray studies of lattice temperature distributions in Si and Ge during irradiation by 15 ns, 0.5–1.5 J/cm² laser pulses. Nanosecond resolution was obtained in these measurements by synchronizing the laser pulses with the ∿0.15 ns synchrotron x-ray pulses and using a gated multichannel analyzer to determine the number of x-rays scattered from individual x-ray pulses. The lattice temperatures and temperature gradients were determined as a function of time following the laser pulses by analyzing time-resolved 111 and 400 Bragg profile measurements in terms of thermal expansion induced strain. The analysis was performed by fitting the measured reflection profiles with dynamical diffraction calculations for one-dimensionally strained crystals. Experimental methods and results, showing surface melting and ∿1000°C/micron temperature gradients, will be discussed for both ruby (694 nm) and excimer (248 nm) laser pulses, and the lattice temperature distributions will be compared to detailed heat flow calculations.

*Research sponsored by the Division of Materials Sciences, U. S. Department of Energy under contract W-7405-eng-26 with Union Carbide Corporation.