Microscopy of Phase Spread Alloy Thin Films

M. Marsh, J. de la Venta, A. Basaran, O. Khatib,
O. Shpyrko, D. Basov, I. Schuller
University of California, San Diego

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1 Introduction:

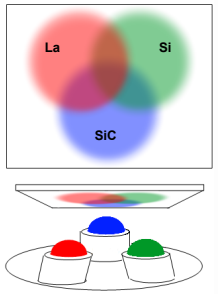
❖The Phase Spread Alloy (PSA) method produces thin films with well-controlled compositional gradients.

❖This is an efficient way to screen multiple compounds and structural phases for superconductivity on one sample

❖We use local and non-local probes to verify the presence and distribution of these phases on one sample

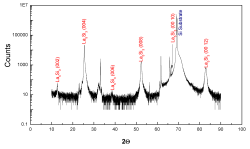
❖The La-Si-C system was chosen for its structural resemblance to high T_c superconductors

2 PSA: Confocal Sputtering System



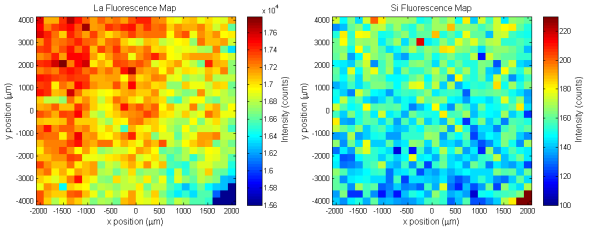
❖ Three sputtering targets are aimed at a substrate (Si or sapphire) resulting in gradients of element concentration

❖ X-ray diffraction shows peaks from the La_5Si_3 phase, along with un-indexed peaks from other phases



Performed by the Schuller group at UCSD

3 X-Ray Fluorescence Maps

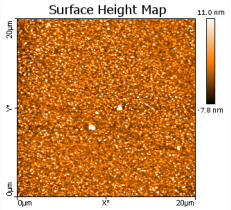


❖ Micro-fluorescence scans showing the La and Si signals from one sample (Si substrate). X-ray beam spot size is 100×100μm.

❖ Beamline 2-ID-D is capable of focusing beam to 200nm×700nm and can also perform micro-diffraction

Performed by the Shpyrko group at beamline 2-ID-D at the Advanced Photon Source at Argonne Nat'l Lab

4 Atomic Force Microscopy

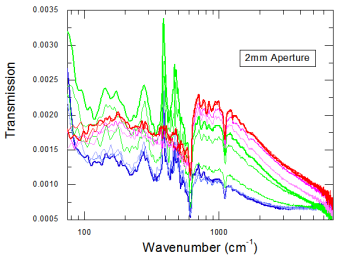


❖ RMS roughness of 3.4 nm over an area of 20×20μm

❖ Roughness is comparable to La films made with the same system with only one gun firing

Performed by the Shpyrko group at UCSD

5 Infrared Spectroscopy



❖ Spectra were taken at eight spots on the sample, spaced by 1mm

❖ Changes at low wavenumber indicate differences in optical conductivity

❖ The Basov group has also developed a scanning probe near-field IR spectroscopy method which can map the optical conductivity of a film with spatial resolution of down to 20nm

Performed by the Basov group at UCSD

6 Conclusions:

❖XRD shows multiple phases present

❖Fluorescence shows the gradient in element concentration

❖IR spectroscopy shows variation in the optical conductivity of different spots on the sample

❖With multiple characterization tools at our disposal, we can thoroughly analyze the composition of PSA thin films and, when found, pinpoint the phase contributing to superconductivity