Validating Simulations of Coherent X-ray Scattering **Experiments in the Hard X-Ray Range**

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Abstract

The Synchrotron Radiation Workshop software (SRW) generates simulations of coherent X-ray scattering and imaging experiments on user-defined samples. SRW supports simulations of both fully and partially coherent radiation propagation through X-ray and infrared beamlines at modern light source facilities. Detailed simulations of coherent X-ray scattering experiments are of paramount importance for modern storage-ring based SR sources. We describe the general approach of SRW simulation methods and present examples of

References

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simulations, and their experimental validation, that were generated using nano fabricated samples that were studied at the Coherent Hard X-ray (CHX) beamline at Brookhaven National Laboratory's National Synchrotron Light Source II (NSLS-II).

Sirepo-Generated Python Source Code Defining CHX Beamline Sample for SRW Simulation

	import srwl_bl	
Sirepo and SRW	import srwlib	
	import srwlpy	
are free to	import srwl_uti_smp	
download		
uowinoau:	Edef set ontics(v=None).	
	el = [1]	
	el.append(srwlib.SRWL0ptA("r", "a", 0.0002, 0.001, 0.0, 0.0))	
	el.append(srwlib.SRWLOptD(6.9))	
	<pre>ifnMirror1 = "mirror_1d.dat"</pre>	
	if ifnMirror1:	
	hProfDataMirror1 = srwlib.srwl_uti_read_data_cols(ifnMirror1, "\t", 0, 1)	
	el.append(srwlib.srwl_opt_setup_surf_height_1d(hProfDataMirror1, _dim="x",	
	el.append(srwlib.SRWLoptD(2.5))	
	el append (srvlib SRWLOPLA(TT, at, 0.0002, 0.001, 0.0, 0.0))	
ing the second	er.append(srwrrb.skwhopcb(1.//)	Optical Flements
1月1万余。(F-161)	opCr = srwlib.SRWL0ptCrvst(d sp=3.13557135638, psi0r=-1.04920331414e-05, ps	
The course are	# Set crystal orientation:	and Drift
	opCr.set_orient(-0.200529604563, 0.958020338708, -0.20490219207, -0.0419796609	⁴ C
	el.append(opCr)	Spaces before
ISRW		the Sample
	el.append(srwlib.SRWLOptD(2.7))	the sample
	el.append(srwlib.SRwLoptA("r", "a", 5e-05, 0.001, 0.0, 0.0))	
	el append (srwlip, srwl.opt setup CPL $(2, 3, 6594020-06, 0, 0087752, 1, 0, 001, 0, 00$	
	el.append(srwlib.SRWLOptD(9.1))	2
	el.append(srwlib.SRWL0ptA("r", "a", 0.0014, 0.0002, 0.0, 0.0))	
	el.append(srwlib.SRWLOptL(3.24479, 1e+23, 0.0, 0.0))	
ielsskiele	<pre>el.append(srwlib.SRWLOptD(3.5))</pre>	
	el.append(srwlib.SRWLOptA("r", "a", 1e-05, 1e-05, 0.0, 0.0))	
	el.append(srwlib.SRWLOptD(0.7))	
e an 🗧 🔽 han i	el.append(srwl_uti_smp.srwl_opt_setup_transm_from_file(
요즘 문제 이 집에 있는 것이 없는 것이 없다.	resolution=20-08 # [m(nivel]	
1793 *** 2226	thickness=5e=08 $\#$ [m]	
nen 2420 - 164	delta=3.227904e-05.	
	atten len=4.06987e-06,	— The Sample
Contraction of the second s	xc=0.0,	
	yc=0.0,	
A	is_save_images =True ,	Drift Space to
Sirepo	prefix='op sample1'))	Drift Space to
	e1.append(srw11b.SRWLOptD(16.046))	Detector

Nano Fabricated Samples (2)

A variety of samples were fabricated by Kevin Yager and Julien Lhermitte using a JEOL JBX6300-FS electronbeam lithography system by patterning gold features onto silicon wafers. We will present our results for three different kinds of nanopatterns: nanodots (roughly hemispherical in shape) arranged in hexagonal arrays, concentric rings, and a combination of nanodots and concentric rings.



Optical Layout of CHX Beamline at NSLS-II

Optical Scheme and Typical X-ray Intensity Distributions



Measurement and Simulation of

Measurement and Simulation of

Measurement and Simulation of

Nano Fabricated Sample Nano Fabricated Sample Hexagonally Packed Cluster of Nanodots Concentric Rings SEM of Sample SEM of Sample 0000 00000

SRW Simulation















CHX Measurement

SRW Simulation

CHX Measurement



8 **Scattered X-Ray Intensity Distribution Cuts Along ~45° Line** Concentric Rings



Nano Fabricated Sample Nanodots and Concentric Rings



SRW Simulation



Scattered X-Ray Intensity Distribution Cuts Along ~50° Line Hexagonally Packed Nanodots and Concentric

National Synchrotron Light Source II





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