US007330530B2

(12) **United States Patent**
Chapman

(10) **Patent No.: US 7,330,530 B2**
(45) **Date of Patent: Feb. 12, 2008**

(54) **DIFFRACTION ENHANCED IMAGING METHOD USING A LINE X-RAY SOURCE**

(75) Inventor: **Leroy Dean Chapman**, Saskatoon (CA)

(73) Assignee: **Illinois Institute of Technology**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/957,884**

(22) Filed: **Oct. 4, 2004**

(65) **Prior Publication Data**

US 2006/0072702 A1 Apr. 6, 2006

(51) **Int. Cl.**
G21K 1/06 (2006.01)
G01T 1/36 (2006.01)

(52) **U.S. Cl.** **378/85**; 378/82; 378/84

(58) **Field of Classification Search** 378/71, 378/84, 85, 70, 82
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,543,630	A	2/1951	Hansen
2,853,617	A	9/1958	Berreman
3,032,656	A	5/1962	Hosemann et al.
3,439,163	A	4/1969	DeJongh
3,628,040	A	12/1971	Schnopper et al.
3,777,156	A	12/1973	Hammond et al.
3,885,153	A	5/1975	Schoenborn et al.
4,223,219	A	9/1980	Born et al.
4,351,063	A	9/1982	Dineen et al.
4,599,741	A	7/1986	Wittry
4,625,323	A	11/1986	Okaya
4,649,557	A	3/1987	Hornstra et al.
4,737,973	A	4/1988	Ogawa et al.
4,949,367	A	8/1990	Huizing et al.
5,123,036	A	6/1992	Uno et al.
5,127,028	A	6/1992	Wittry
5,164,975	A	11/1992	Steinmeyer
5,195,115	A	3/1993	Schiller et al.
5,245,648	A	9/1993	Kinney et al.

(Continued)

FOREIGN PATENT DOCUMENTS

WO	95/05725	2/1995

OTHER PUBLICATIONS

D. Chapman, W. Thomlinson, R.E. Johnson, D. Washburn, E. Pisano. N. Gmür, Z. Zhong, R. Menk, F. Arfelli and D. Sayers, *X-Ray Refraction Imaging (XRI) Applied to Mammography,* published Oct. 31, 1997.

(Continued)

Primary Examiner—Chih-Cheng G Kao
(74) *Attorney, Agent, or Firm*—Pauley Petersen & Erickson

(57) **ABSTRACT**

A method for detecting an enhanced image of an object by independently analyzing, detecting, digitizing, and combining images acquired on a high and a low angle side of a rocking curve of a crystal analyzer. An x-ray beam generated by a line x-ray source is collimated by a crystal monochromator including two non-matching crystals to form an x-ray area beam. The x-ray area beam is transmitted through an object to be imaged and onto an image detector and the image is digitized. The digitized images are simultaneously solved, preferably on a pixel-by-pixel basis, to derive an enhanced image which has dramatically improved contrast and spatial resolution over an image acquired through conventional radiology methods.

17 Claims, 3 Drawing Sheets