论文

空间相干与入射光子能量对临床类同轴X射线相衬成像影响

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摘要：

在临床实际应用中,X射线源是一个具有有限尺寸的多色光源.基于Fresnel-Kirchhoff衍射理论,考虑空间相干的影响,新的类同轴X射线相衬成像公式被导出.分别代表吸收效应与相位效应的吸收衬度传递函数和相位衬度传递函数从新公式得到.吸收衬度传递函数和相位衬度传递函数的曲线由Matlab给出,不同源半径的最佳成像位置也被计算.理论分析结果如下:1）当光源半径足够大时空间相干效应须被考虑,减小源半径可以增强相位效应|2）源半径与最佳成像位置间有确定关系,并在本文中给出|3）源尺寸效应对相位效应影响不是无限的|4）减小入射X射线光子能量将会显著增强相位效应,但不会对最佳成像位置有影响,因此,上述结论可以被拓展到多色光情况.为了验证理论结果,本文给出了对一个表面破损的光学玻璃微聚焦相衬成像的实验结果.其中一些实验结果与理论分析符合很好,但也有一些实验未达到预期,相关的解释文中也已给出.

关键词：　相衬成像　吸收衬度传递函数　相位衬度传递函数

Effect of Spatial Coherence and in Incident X-ray Photon Energies on Clinical X-ray In-line Phase-contrast Imaging

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Abstract:

X-ray source is usually considered as a monochromatic point source,regardless of whose size effect.However,in clinical practical applications,an X-ray tube is a polychromatic source with a finite focal spot.The incident X-ray source was supposed as the average intensity distribution of a qusi-monochromatic light circular source in the beginning,and then it was extended to the polychromatic case.Based on Fresnel-Kirchhoff diffraction theory,taking the spatial coherence into account,the new in-line X-ray Phase-contrast imaging formula was derived by Fourier transform.The absorption contrast transmission function γre and phase contrast transmission function $\gamma re2\pi\lambda R2u2/M$ were obtained from the new formula,which represented absorption effect and phase effect,respectively.The curves of the above functions for different radiuses were given by software Matlab and the optimal positions for different source radiuses were also calculated.The theoretical analysis results are as follows:1) the spatial coherence effect should be considered when source radius is bigger enough,and decreasing the source radius would increase phase effect|2) there is the definitive relationship between the radius and the optimal imaging position,which has been presented in a special case|3) the effect of source size on phase effect is not infinite,which could be ignored when the size is equal to a suitable value.The suitable radius is given in a special case|4) decreasing incident X-ray photon energies would strengthen PE obviously,and the variation of photon energies has no effect on the optimal imaging position|as a result,the new formula could be extended to the polychromatic case.In order to verify the theoretical results,the micro-focus X-ray phase-contrast imaging experiments for the breakage surface of optical glass detection were carried out.Some experimental results are in good agreement with theoretical analysis,while some do not meet our expectations.The related explanations were also presented.

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参考文献：

[1]POGANY A,GAO D,WILKINS S W.Contrast and resolution in imaging with a microfocus X-ray source [J].Review of Scientific Instruments,1997,68(7):2774-2782.

[2]MOMOSE A,TAKEDA T,ITAI Y.Phase-contrast x-ray computed tomography for observing biological specimens and organic materials[J].Review of Scientific Instruments,1995,66(2):1434-1436.

[3]YONEYAMA A,TAKEDA T,TSUCHIYA Y,et al.Coherence-contrast X-ray imaging based on X-ray interferometry[J].Applied Optics,2005,44(16):3258-3261.

[4]PFEIFFER F,BUNK O,DAVID C,et al.High-resolution brain tumor visualization using three-dimensional X-ray phase contrast tomography[J].Physics in Medicine and Biology,2007,52:6923-6930.

[5]DAVIS T J,GAO D,GUREYEV T E,et al.Phase contrast imaging of weakly absorbing materials using hard X-rays[J].Nature,1995,373(16):595-598.

[6]KOBAYASHI K,IZUMI K,KIMURA H,et al.X-ray phase-contrast imaging with submicron resolution by using extremely asymmetric Bragg diffractions[J].Applied Physics Letters,2001,78(1):132-134.

[7]MENK R H,RIGON L,ARFELLI F.Diffraction-enhanced X-ray medical imaging at the ELETTRA synchrotron light source[J].Nuclear Instruments and Methods in Physics Research Secti A,2005,548:213-220.

[8]GUIGAY J P,PAGOT E,CLOETENS P.Fourier optics approach to X-ray analyzer-based imaging[J].Opt Commun,2007,270(2):180-188.

[9]WU Xi-zeng,LIU Hong.A general theoretical formalism for X-ray phase contrast imaging[J].Journal of X-ray Science and Technology,2003,11(1):33-42.

[10]GUREYEV T E,NESTERETS Y I,PAGANIN D M,et al.Effects of incident illumination on in-line phase-contrast imaging[J].JOSA A,2006,23(1):34-42.

[11]WU Xi-zeng,LIU Hong.Clinical implementation of X-ray phase contrast imaging:theoretical foundation and design consideration[J].Medical Physics,2003,30(8):2169-2179.

[12]ZHANG Xue-long,LIU Song,HUANG Yong,et al.Optimal Contrast for X-ray Phase-contrast imaging.Acta Photonica Sinica,2008,37(6):1217-1220.

[13]XIA Tian,ZHANG Xue-long,ZHANG Guo-ying.Analysis of the absorption and the phase-effect on micro-focus X-PCI[J].Acta Photonica Sinica,2009,38(10):2516-2160.

[14]WU X Z,DEAN A,LIU H.X-ray diagnostic techniques biomedical photonics handbook [M].Tampa,FL:CRC Press,2003:1116.

[15]SNIGIREV A,SNIGIREVA I,KOHN V,et al.On the possibilities of X-ray phase contrast microimaging by coherent high-energy synchrotron radiation[J].Scientific Instruments,1995,66(12):5486-5492.

[16]WILKINS S,GUREYEV T,GAO D,et al.Phase-contrast imaging using polychromatic hard x-rays [J].Nature,1996,384(28):335-338.

[17]BORN M,WOLF E.Principles of optics:electromagnetic theory of propagation,interference and diffraction of light[M].7th ed.Cambridge,England:Cambridge University Press,1999.

[18]ATTWOOD D T.Soft X-ray and extreme ultraviolet radiation:principles and application [M].Cambridge:Cambridge University Press,1999.

[19]WU X Z,LIU H,YAN A.Optimization of X-ray phase-contrast imaging based on in-line holography [J].Nuclear Instruments and Methods in Physics Research Section B,2005,234(4):563-572.

[20]WU X Z,LIU H.An experimental method of determining relative phase- contrast factor for X-ray imaging systems[J].Medical Physics,2004,31:997-1002.

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