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微纳技术与精密机械

使用山嵛酸银标定中子小角散射谱仪的关键参数

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摘要: 为了快速标定中子小角散射谱仪的关键参数:速度选择器的选择波长和波长分辨率以及谱仪布局下的Q分辨率,采用实验方法对山嵛酸银粉末的中子小角散射实验数据进行了拟合。首先,确定谱仪布局,包括准直光阑孔径大小、准直长度、样品到探测器之间的距离;其次,在中子小角散射谱仪的机械速度选择器设置在3 000、4 000、5 000和6 000 r·min⁻¹ 4种不同转速下,测定山嵛酸银粉末的中子小角散射谱;最后,对实验数据进行反演分析。通过分析,计算出该机械速度选择器常数为2 329.2 r·m⁻¹·nm,从而得到了4种不同转速所对应的选择波长分别为0.776、0.582、0.466、0.388 nm;通过对实验数据的拟合还得到了该速度选择器的波长分辨率(23.75%),以及在此谱仪布局下的Q分辨率曲线。结果表明,使用山嵛酸银粉末的中子小角散射能够较好地标定谱仪的关键参数,从而支持对中子小角散射数据的正确分析和反演。

关键词: 中子小角散射谱仪 山嵛酸银 选择波长 波长分辨率 标定

Calibration of key parameters for small angle neutron scattering spectrometer by using silver behenate

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Abstract: To calibrate quickly key parameters of a small angle neutron scattering spectrometer, such as selecting neutron wavelengths, wavelength resolution, and the Q resolution under a geometrical layout of the spectrometer, the experiment data of small angle neutron scattering for silver behenate powder were fitted. First, the geometrical layout of spectrometer was chosen including the size of circular source, sample apertures of the collimator, the source-to-sample distance and the sample-to-detector distance. Then, the spectra of small angle neutron scattering on silver behenate were obtained under four different revolving speeds of mechanical velocity selector. Finally, these experiment data were inverted and analyzed. Obtained results show that the velocity selector constant is 2 329.2 r·m⁻¹·nm, correspondingly, four different selecting neutron wavelengths are 0.776、0.582、0.466、0.388 nm, respectively. The wavelength resolution of the velocity selector is 23.75% by fitting these experiment data and the spectrometer Q resolution curves can be obtained by using the chosen layout parameter and different rotating speeds. It concludes that the key parameters of small angle neutron scattering spectrometer can be achieved by using silver behenate, which supports the exact analysis and inversion for experiment data of small angle neutron scattering.

Keywords: Small angle neutron scattering spectrometer Silver behenate Selection wavelength Wavelength resolution Calibration

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参考文献:

- [1] 闫冠云, 黄朝强, 孙光爱, 等. 降感RDX微观结构的X射线小角散射分析[J]. 含能材料, 2010, 18(05): 492-496. YAN G Y, HUANG CH Q, SUN G A, et al.. RDX Micro-structure by SmallAngle X-Ray Scattering [J]. Chinese Journal of Energetic Materials, 2010, 18(05): 492-496. (in Chinese) [2] 闫冠云, 田强, 黄朝强, 等. 热损伤奥克托金(HMX)缺陷的X射线小角散射研究[J]. 物理学报, 2012, 61(13): 136101: 1-7. YAN G Y, TIAN Q, HUANG CH Q, et al.. A small-angle X-ray scattering study of micro-defects in thermally treated HMX [J]. Acta Physica Sinica, 2012, 61(13): 136101: 1-7. (in Chinese) [3] 沈业青, 邓敏, 陆安群. 利用同步辐射X射线小角散射研究超低水灰比水化水泥早期微结构[J]. 硅酸盐学报, 2012, 40(5): 691-695. SHEN Y Q, DENG M, LU A Q. Early age microstructure of hydrating cement with ultra-low water to cement ratio investigated by synchrotron SAXS[J]. Journal of the Chinese Ceramic Society, 2012, 40(5): 691-695. (in Chinese) [4] 程伟东, 孙民华, 李佳云, 等. Cu₆₀Zr₃₀Ti₁₀非晶合金弛豫和晶化过程的小角X射线散射研究[J]. 物理学报, 2006, 55(12): 6732-6676. CHENG W D, SUN M H, LI J Y, et al.. Small angle X-ray scattering research of the relaxation and crystallization process in Cu₆₀Zr₃₀Ti₁₀ amorphous alloy [J]. Acta Physica Sinica, 2006, 55(12): 6732-6676. (in Chinese) [5] 孙光爱, 陈波, 吴二冬, 等. 蠕变镍基单晶高温合金微观结构与界面特征的X射线小角散射研究[J]. 物理学报, 2011, 60(1): 016102-016108. SUN G A, CHEN B, WU E D, et al.. Small angle X-ray scattering study of the microstructure and interface characteristics of single crystal superalloys during creep process[J]. Acta Physica Sinica, 2011, 60(01): 016102-016108. (in Chinese) [6] XIA Q Z, CHEN B, LEBEDEV V T, et al.. Investigation on defects in mg and al alloys under dynamic loading by the small-angle scattering method[J]. Physica B, 2006, (385-386): 614-616. [7] 李新喜, 王燕, 黄朝强, 等. 展盘产生的中子脉冲特性[J]. 光学精密工程, 2009, 17(9): 2112-

2119. LI X X, WANG Y, HUANG CH Q, et al.. Neutron pulse speciality produced by chop disk[J]. Opt. Precision Eng., 2009,17(9):2112-2119. (in Chinese) [8]李新喜, 王燕, 黄朝强, 等. 中子反射谱仪的闸门与会聚导管组合设计[J]. 光学精密工程, 2009, 17(12): 2983-2989. LI X X, WANG Y, HUANG CH Q, et al.. Optimized combination of shutters and focus neutron guides for neutron reflectometers[J]. Opt. Precision Eng.,2009,17(12):2983-2989. (in Chinese) [9]王晓影, 李建, 谢超美, 等. 中子衍射应力谱仪垂直聚焦单色器的优化设计[J]. 光学精密工程, 2008, 16(10): 1880-1885. WANG X Y, LI J, XIE CH M, et al.. Optimal simulation of vertical monochromator of neutron diffraction residual stress instrument [J]. Opt. Precision Eng., 2008,16(10):1880-1885. (in Chinese) [10]陈波, 夏庆中, LEBEDEV V T. 富勒烯-PVP聚合物链团结构的中子小角散射实验研究[J]. 物理学报, 2005, 54(6): 2821-2825. CHEN B, XIA Q ZH, LEBEDEV V T. Experimental study of fullerene-PVP polymers by small-angle neutron scattering [J]. Acta Physica Sinica, 2005,54(6):2821-2825. (in Chinese) [11] NAGORNYI A V, PETRENKO V I, AVDEEV M V, et al.. Analysis of small_angle neutron scattering from very dilute magnetic fluids[J]. Journal of Surface Investigation. X-ray, Synchrotron and Neutron Techniques,2010,4(6):976-981. [12] KULVELIS Y V, LEBEDEV V T, TRUNOV V A, et al.. Structure of complexes of sulphuretted tetraphenylporphine with Poly_N_vinylpyrrolidone according to the data of Small_Angle Neutron scattering [J]. Journal of Surface Investigation. X-ray, Synchrotron and Neutron Techniques, 2011,5(1):113-119. [13]MARCANO N, G MEZSAL J C, ESPESO J I, et al.. Mesoscopic magnetic states in metallic alloys with strong electronic correlations: a percolative scenario for CeNi_{1-x}Cu_x [J]. Physical Revive Letters, 2007,98: 166406-199409. [14]ULBRICHT A, HEINTZE C, BERGNER F, et al.. SANS investigation of a neutron -irradiated Fe - 9 at%Cr alloy [J]. Journal of Nuclear Materials, 2010,407:29-33. [15] KULVELIS Y V, LEBEDEV V T, TRUNOV V A, et al.. Investigation of polymer hydrogels with memory effect for cefazolin immobilization by Small_angle neutron scattering[J]. Journal of Surface Investigation. X-ray, Synchrotron and Neutron Techniques, 2012,6(5):825-832. [16]TOMCHUK O V, AVDEEV M V, AKSENOV V L, et al.. Comparative structural characterization of the water dispersions of detonation nanodiamonds by Small_Angle neutron scattering[J]. Journal of Surface Investigation. X-ray, Synchrotron and Neutron Techniques, 2012,6(5):821-824. [17]LEBEDEV V M, LEBEDEV V T, ORLOV S P. Small_Angle neutron scattering studies on the structure of radiation defects in Neutron_Irradiated synthetic quartz [J]. Journal of Surface Investigation. X-ray, Synchrotron and Neutron Techniques, 2012,6(5):718-721. [18]丁大钊, 叶春堂, 赵志祥. 中子物理学[M]. 北京: 原子能出版社, 2001: 748. DING D ZH, YE CH T, ZHAO ZH X. Neutron Physics [M]. Beijing: Atom Energy Press, 2001. (in Chinese). [19]ROSTA L. Multi-disk neutron velocity selectors [J]. Physica B,1989,156-157: 615-618. [20]HAMMOUDA B. Multidisk neutron velocity selectors[J]. Nuclear Instruments and Methods in Physics Research A,1992,321:275-283. [21]GILLES R, KEIDERLING U A. Wiedenmann silver behenate powder as a possible low-angle calibration standard for small-angle neutron scattering[J]. Journal of Applied Crystallography, 1998,31:957-959. [22]PEDERSEN J S. Resolution effects and analysis of small-angle neutron scattering data[J]. suppltment au Journal de Physique I,1998, 3(12):491-498. [23]陈良, 彭梅, 孙良卫, 等.机械速度选择器特征参数计算[J]. 核电子学与探测技术, 2010, 30(7): 925-928. CHEN L, PENG M, SUN L W, et al.. Characteristic parameters calculation of mechanical velocity selector[J]. Nuclear Electronics & Detection Technology, 2010,30(7): 925-928. (in Chinese) [24]陈良, 彭梅, 王燕, 等. 中子小角散射谱仪Q分辨率计算和对形状因子影响分析[J]. 核电子学与探测技术, 2011, 31(5): 530-533. CHEN L, PENG M, WANG Y, et al.. Q resolution calculation of small angle neutron scattering spectrometer and analysis of form factor [J]. Nuclear Electronics & Detection Technology, 2011,31(5):530-533. (in Chinese) [25]MILDNER D F R, HAMMOUDA B, KLINE S R. A refractive focusing lens system for small-angle neutron scattering[J]. Journal of Applied Crystallography, 2005, 38:979-987. [26]PEDERSEN J S. Resolution effects and analysis of small-angle neutron scattering data[J]. Journal De Physique IV,1993,3(12):491-498. [27]魏国海, 刘祥锋, 李天富, 等. 中子小角散射实验及原始数据的处理[J]. 核技术, 2010,33(4): 253-257. WEI G H, LIU X F, LI T F, et al.. Small angle neutron scattering experiment and raw data reduction[J]. Nuclear Techniques, 2010,33(4):253-257. (in Chinese)

本刊中的类似文章

1. 冯萍 魏振忠.光笔式大视场三维视觉测量系统[J]. 光学精密工程, 2013,21(9): 2217-2224
2. 刘书桂 董英华 姜珍珠.光笔式视觉测量系统中的测头中心自标定[J]. 光学精密工程, 2013,21(7): 1727-1733
3. 徐涛 李博 刘廷霞 薛乐堂 陈涛.车载光电跟踪系统跟踪转台的初始标定[J]. 光学精密工程, 2013,21(3): 782-789
4. 梁经伦 陈家钊 莫景会 邝泳聪 张宪民.精密视觉印刷设备的自标定[J]. 光学精密工程, 2013,21(2): 522-530
5. 李伟 王伯雄 杨春毓.基于正交双目视觉的药液杂质粒径标定[J]. 光学精密工程, 2013,21(10): 2603-2609
6. 尤晶晶 李成刚 吴洪涛.并联式六维加速度传感器的参数辨识[J]. 光学精密工程, 2013,21(10): 2627-2638
7. 王向军 王晶 刘峰 王剑 张召才.野外大视场双目视觉物体定位监测系统的单参数快速标定[J]. 光学精密工程, 2013,21(10): 2664-2670
8. 郭方 王克逸 吴青林.多通道大视场目标定位仪的研制[J]. 光学精密工程, 2013,21(1): 26-33
9. 储琨 郭卢安政 赵贵花.采用环形模板的棋盘格角点检测[J]. 光学精密工程, 2013,21(1): 189-196
10. 李磊刚, 梁晋, 唐正宗, 郭成, 崔学龙.飞机结构件运动数据的动态视觉测量系统[J]. 光学精密工程, 2012,20(9): 1929-1938
11. 崔继文, 刘雪明, 谭久彬.超精密级二维工作台的自标定[J]. 光学精密工程, 2012,20(9): 1960-1966
12. 张文秀, 林君, 周逢道, 刘立超.分布式电磁接收系统多频标定信号的产生与检测[J]. 光学精密工程, 2012,(8): 1862-1869
13. 王素华, 沈湘衡, 叶露.可调对比度目标源装置中对比度的标定[J]. 光学精密工程, 2012,20(5): 949-956
14. 全伟, 刘阳, 王广君.基于姿态矩阵判据的光学焦距在线快速标定[J]. 光学精密工程, 2012,20(5): 934-941
15. 郭方, 王克逸, 闫佩正, 吴青林.用于大视场目标定位的复眼系统标定[J]. 光学精密工程, 2012,20(5): 913-920