

背散射分析测定锆(铯漂移)表面的氟化钙薄膜厚度

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关键词: 背散射测厚 锆基体 氟化钙膜

在制造同轴锆(铯漂移)探测器时,为了减少表面漏电流、降低噪声,需要在锆表面生长一层有一定厚度的氟化钙复盖膜。因此,在选择加工工艺条件时,要求测量此层的厚度。

背散射分析一般不适合于测量重基体表面上的轻材料薄膜。我们用测量基体背散射能谱的位移量的方法,测出了锆(铯漂移)表面上氟化钙薄膜的厚度。

如图1所示,(a)为没有氟化钙薄膜的锆(铯漂移)样品(零样品),(b)为有氟化钙复盖膜的锆(铯漂移)样品。对于后者,由于有氟化钙薄膜的阻止作用,带电粒子在入射和出射过程中都将在氟化钙膜中损失一些能量,所以它的锆散射能谱相对于零样品有一个能量位移 ΔE 。在我们的实验条件下(见图2),分析束是184keV的质子束,散射角为 162.5° ,样品表面法线与入射束成 45° 角。有^[1]:

$$\Delta E = [\varepsilon]_{\text{CaF}_2} \cdot N \cdot t \quad (1)$$

$$[\varepsilon]_{\text{CaF}_2} = \frac{K_{\text{Ge}}}{\cos 45^\circ} \varepsilon_{\text{CaF}_2}(E_0) + \frac{1}{\cos 27.5^\circ} \varepsilon_{\text{CaF}_2}(KE_0) \quad (2)$$

$$\varepsilon_{\text{CaF}_2} = \varepsilon_{\text{Ca}} + 2\varepsilon_{\text{F}} \quad (3)$$

(1)、(2)、(3)式中, $N \cdot t$ 是氟化钙的分子面密度; $[\varepsilon]_{\text{CaF}_2}$ 是入射粒子在氟化钙中的背散射阻止截面因子; $\varepsilon_{\text{CaF}_2}(E_0)$ 及 $\varepsilon_{\text{CaF}_2}(KE_0)$ 分别是氟化钙分子对于能量为 E_0 及 KE_0 的粒子的阻止截面; ε_{Ca} 及 ε_{F} 分别是钙原子及氟原子对粒子的阻止截面; K_{Ge} 是锆的背散射运动学因子。

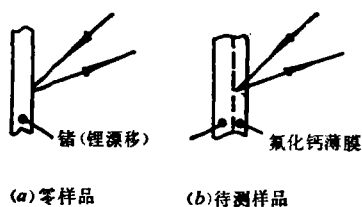


图1 背散射示意图

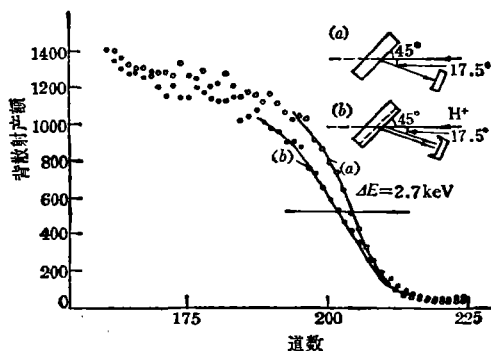


图2 锆(铯漂移)的背散射能谱

(a)表面没有复盖氟化钙膜 (b)表面复盖氟化钙膜

ΔE 由实验测得,通过(1)、(2)、(3)式就可求得氟化钙薄膜的厚度 t 。实验对两种不同工艺条件下制作的1号及2号样品进行了测量,结果分别为 $99\text{\AA}$ ($1 \pm 25\%$) 和 $113\text{\AA}$ ($1 \pm 25\%$)。图2为测得的1号样品及零样品的背散射能谱。

本实验中所用样品由中国科学院上海原子核研究所五室提供,特此致谢。

参 考 文 献

[1] J. W. Mayer and E. Rimini, Ion beam handbook for material Analysis, Academic Press. Inc., New York, San Francisco, London, 1977, p.43.

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calculator and presents two programs which have been used in the analysis of multicomponent gamma-ray spectra obtained from NaI(Tl) scintillation spectrometer. The results show that this method is satisfactory, and the programs can also be used in other types of small computer.

The preparation of ^{61}Cu

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^{61}Cu produced by alpha particle bombardment of natural nickel target was separated from target and purified with anion exchanger. The method is as follows. ^{61}Cu is adsorbed on strong alkali anion exchanging column from 8N HCl with a large amount of Ni passing through. 2N HCl is then used to elute ^{61}Cu from the column. By checking of γ -spectrum and half-life the ^{61}Cu thus formed is proved pure enough for determination of its nuclear parameters. The method can also be applied to prepare medical radioisotope ^{62}Zn from 30MeV α particle bombarded Ni target. However, 0.05N HCl is used to elute ^{62}Zn .

The thickness measurements of the CaF_2 layer on the Ge monocrystal by backscattering

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This paper describes that light elements thickness on a heavy substrate have been measured by RBS (Rutherford backscattering spectroscopy).

From the backscattered energy spectrum shift of the substrate Ge, the thickness of the thin CaF_2 layer on the monocrystal Ge has been determined. The results of measurements for sample 1 and 2 are $99\text{ \AA}$ ($1+25\%$), $113\text{ \AA}$ ($1+25\%$) respectively.

Preparation of the ^{131}I tracer of petroleum oil

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The leak detection tests of oil pipe line were carried out in Nu county Shandong province, using oil tracer of iodo-benzene ($\text{C}_6\text{H}_5^{131}\text{I}$) labeled by ^{131}I . $\text{C}_6\text{H}_5^{131}\text{I}$ was obtained through iodination of diazotized aniline. Because of the diazo-compound is unstable, thus the iodo-benzene must be prepared in site. Apparatus for semi-automatic and remote operation was designed. More than 300 mCi of $\text{C}_6\text{H}_5^{131}\text{I}$ were prepared successfully and mixed with ten tons of petroleum, for leak detection of oil pipe line. It was demonstrated that the test was safe and reliable.