深紫外非线性光学晶体$BaMgF_4$的表征

Characterization of Deep ultra-violet nonlinear optical crystal $BaMgF_4$

深紫外铁电氟化物晶体$BaMgF_4$由于具有极短的紫外截止波长（125nm），有望作为非线性光学倍频晶体，实现深紫外全固态激光器的制造。目前对其非线性性质的研究还不够充分。我们课题组通过实验测量了$BaMgF_4$三个晶轴方向上的三阶非线性系数，发现其具有较大的各项异性。其中最大值为$2.35\times10^{-18}m^2/W$，这在已知的铁电晶体中几乎是最大的。这说明具$BaMgF_4$有明显的三阶非线性现象。于是，我们研究了它的自位相调制效应，并与传统的铁电晶体$LiNbO_3$进行了比较。另外，我们还进行了初步的铁电畴极化实验，发现$BaMgF_4$的单畴呈现六边形。

The $BaMgF_4$ single crystal is grown by Bridgman method. The third-order nonlinear refractive indices along three crystallographic axes are determined by Z-scan technique with femtosecond laser for the first time. The largest one which has a value of $2.35\times10^{-18}m^2/W$ is along the c-axis and the corresponding third-order nonlinear susceptibility is 1.24×10^{-12}esu . This value is compared with $LiNbO_3$ through self-phase modulation effect. Furthermore, the poling experiment is performed to investigate its ferroelectric property .

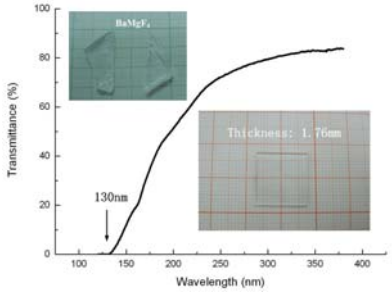

Figure 1 | UV/UVU transmittance spectrum of the $BaMgF_4$ single crystal with a thickness of 1.76 mm shown in the inset.
图1 | $BaMgF_4$晶体紫外透过率谱

The VUV absorption edge of $BaMgF_4$ is about 130 nm. There is a relatively high transmittance in the VUV region so that many nonlinear processes in $BaMgF_4$ can be observed in this region. According to the absorption edge, its band gap can be estimated at 9.5 eV.

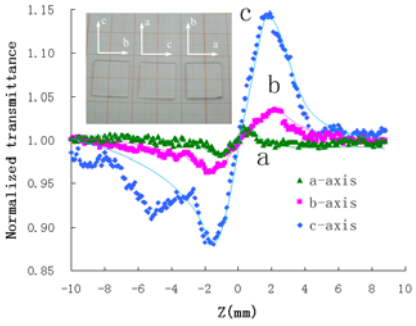

Figure 2 | Z-scan traces and fittings of the $BaMgF_4$ crystal along a-, b- and c-axis, respectively. The irradiance at the focus is 4.3GW/ cm2.
图2 | 沿着$BaMgF_4$晶体三个轴向上的Z-scan曲线

The Z-scan measurement shows that the third-order nonlinear refractive indices of $BaMgF_4$ have strong anisotropy. The largest one is along c-axis, possessing a value of $2.35\times10^{-18}m^2/W$.

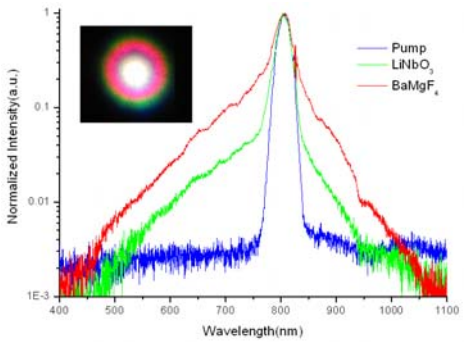

Figure 3 | Supercontinuum spectra of $BaMgF_4$ and $LiNbO_3$. The propagation distance in the crystal is 1 mm and the irradiance is $1\times10^{18}W/m^2$
图3 | $BaMgF_4$晶体和$LiNbO_3$晶体超连续谱

In the same environment, the spectrum of $BaMgF_4$ is obviously wider than that of LiNbO3, and it conversely demonstrates that $BaMgF_4$ has larger third-order nonlinear refraction because of the self-phase modulation effect.

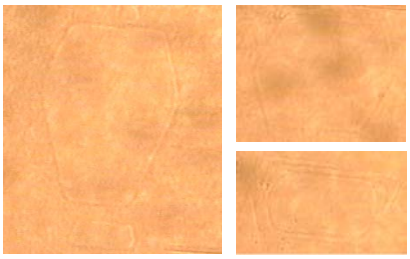

Figure 4 | Micrograph of single domains on the $BaMgF_4$ wafer with thickness of 0.5mm
图4 | $BaMgF_4$单畴显微照片

After poling experiment, the profile of single domains on the +Z surface of the $BaMgF_4$ wafer can be observed. Most of the shapes are hexagon. The orientation of the sides may depend on the crystallographic planes of $BaMgF_4$ crystal.

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