SHG properties of MgO-doped $LiNbO_3$ single crystals.

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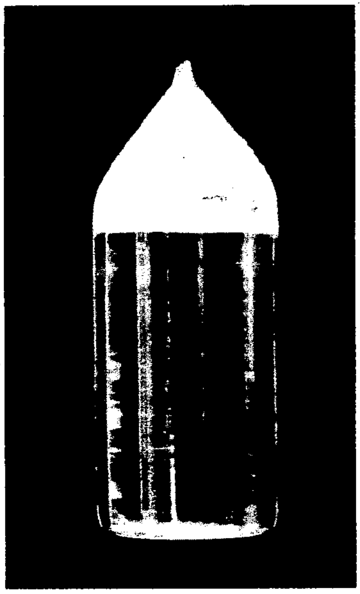
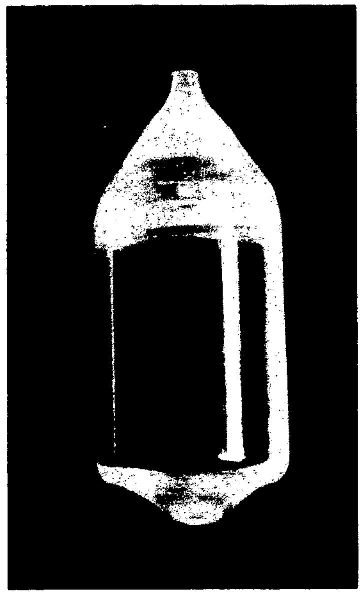
Abstract

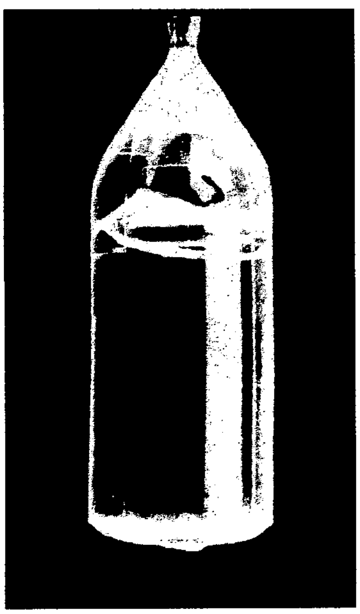
The MgO-doped $LiNbO_3$ single crystals were grown along c-axis by the Czochralski method with the pulling rate of 3mm/h and the rotation of 10rpm. The MgO contents were from 1 to 4 mole%. The SHG properties were investigated with the pulsed Nd:YAG laser, and thermo-optic coefficient, electro-optic coefficient of birefringence and Curie temperature were measured. Phase matching temperature and Curie temperature increase similarly with MgO content until 4 mole%.



a) 1MgO:LN



b) 2MgO:LN



c) 3MgO:LN

d) 4MgO:LN

Fig.1. Single crystals of MgO-doped LN

Intensity of second harmonic wave .

$$I(2\omega) = \frac{cn}{2\pi} E^{2\omega} E^{2\omega *}$$

$$= \frac{512\pi^5 d^2 L^2}{n(2\omega)n(\omega)^2\lambda^2 c} I(\omega)^2 \left[\frac{\sin(\frac{\Delta kL}{2})}{(\frac{\Delta kL}{2})} \right]^2$$

$$\Delta k = 2k(\omega) - k(2\omega) = 2\frac{\omega}{c}[n_o(\omega) - n_e(2\omega)]$$

If the temperature is changed and electric field is applied then phase-mismatching can be written like below.

$$\Delta k = 2\frac{\omega}{c}[n_o(\omega) - n_e(2\omega) + \alpha(T - T_{pm}) + \beta\frac{V}{t}]$$

$$\alpha = \frac{d[n_o(\omega) - n_e(2\omega)]}{dT}$$

$$\beta = \frac{1}{2}[\gamma_{13}(\omega) n_o(\omega)^3 - \gamma_{33}(2\omega) n_e(2\omega)^3]$$

V : *Applied voltage*

t : *Distance of electrode (thickness of c−axis)*

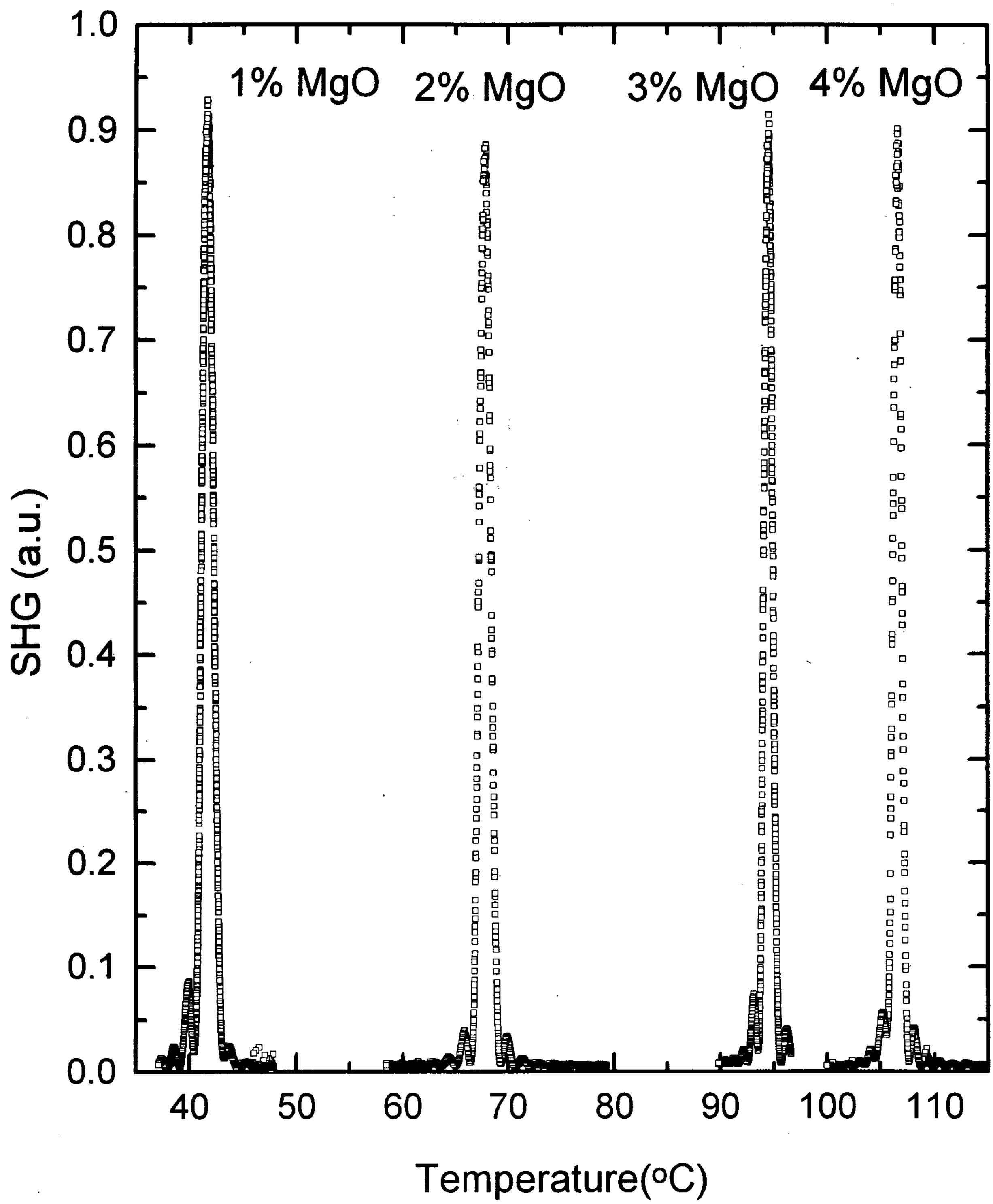


Fig.2. Temperature phase -matching profiles of MgO-doped LN

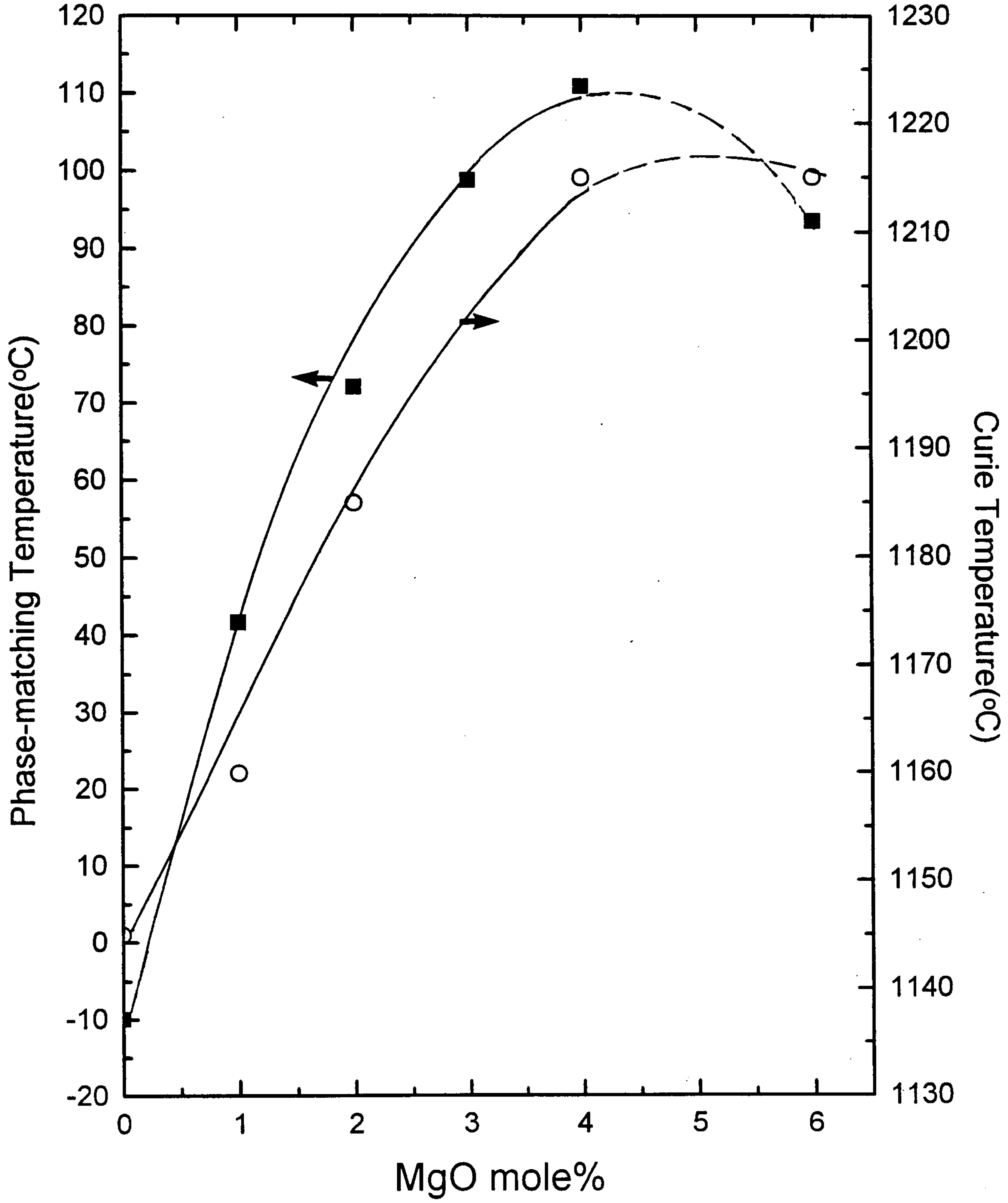


Fig.3. Curie temperature and phase-matching temperature as the function of MgO contents in LN

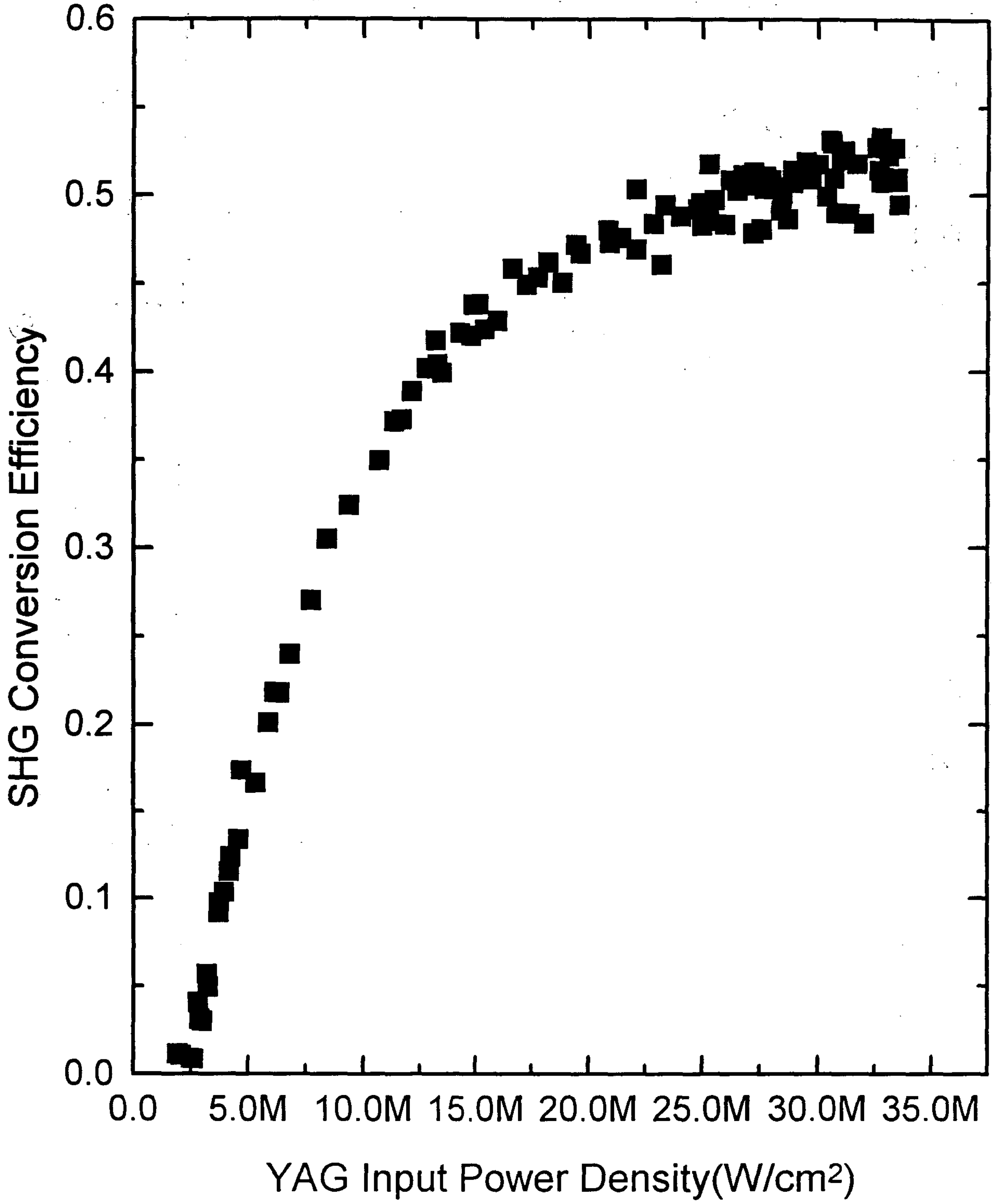


Fig.4. SHG(1064nm-532nm) converson efficiency with the pulsed laser in 2MgO:LN (L=10.3mm)

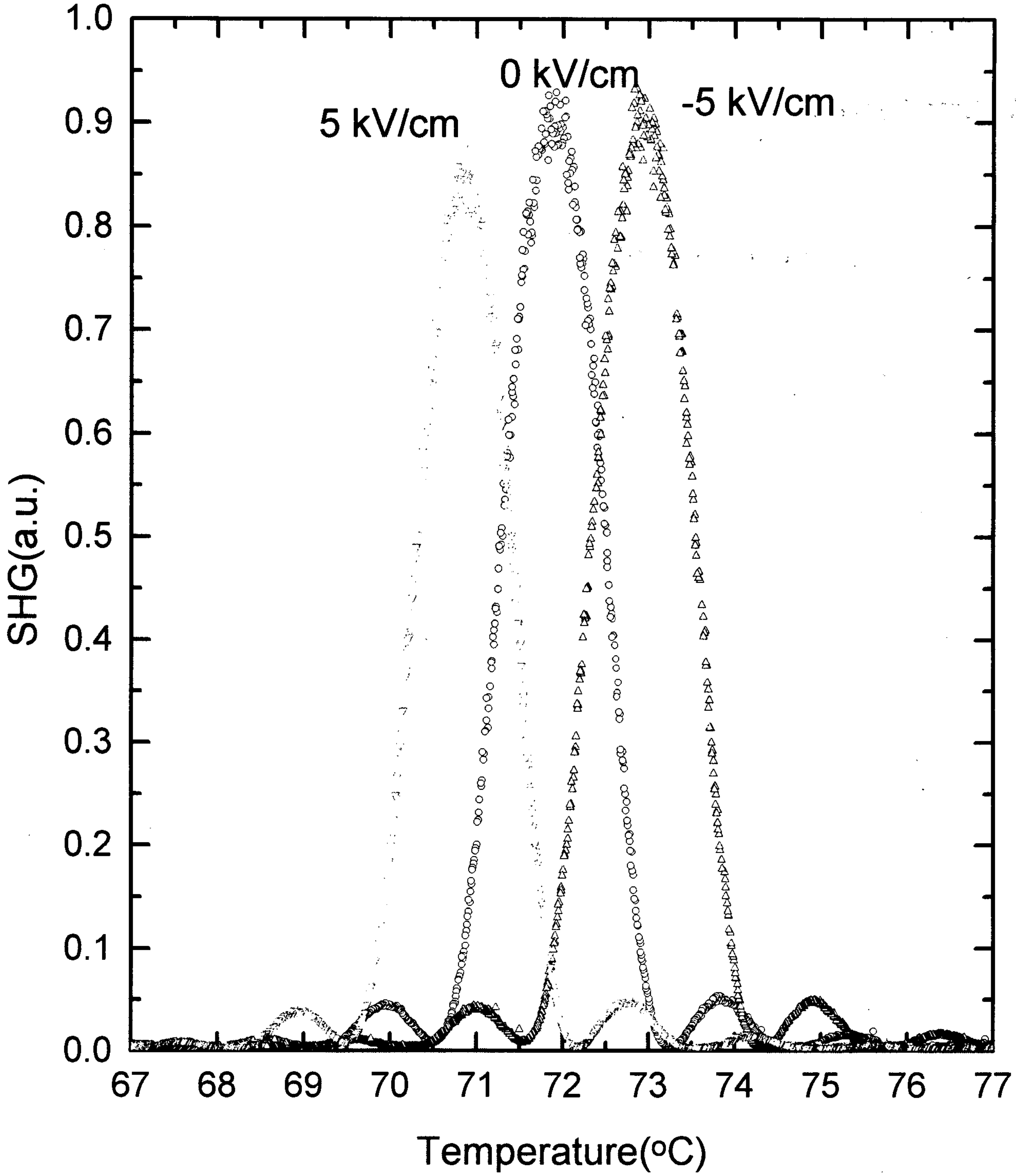


Fig. 5. Electric field dependence of phase-matching Temperature in 2Mg:LN

Conclusions

1. $T_{pm} \propto$ MgO content in LN.

2. Tc $\propto$ MgO content in LN.

3. $T_{pm} \propto T_c$

4. In 2 mole% MgO-doped LN

   Thermo-optic coefficient of birefrigence

   $$\alpha = 6.03 \times 10^{-5} (^{o}C)^{-1}$$

   Electro-optic coefficient of birefrigence

   $$\beta = 1.32 \times 10^{-8} (V/cm)^{-1}$$

5. In 2 mole% MgO-doped LN

   The SHG conversion efficiency was archived 50% at the power density of 32 MW/cm^2