DOCTORAL THESIS

# Dielectric properties and defects structure of lead tungstate crystal

Li, Wensheng

*Date of Award:*
2000

# Dielectric Properties and Defects Structure of Lead Tungstate Crystal

LI Wensheng

A thesis submitted in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

September 2000

Hong Kong Baptist University

# Abstract

A detailed investigation has been carried out into the defects structure of lead tungstate, $PbWO_4$, in the pristine state, annealed in oxygen, or doped with La, Y or Sb. A number of important conclusions have been reached. The experimental evidence has come from the dielectric spectra, UV–visible transmittance spectra, Thermoluminescence, dc resistivity, XPS, TG and DSC measurements.

In as–grown PWO, after UV–irradiation, dielectric relaxation peaks were observed, at room temperature in the kHz region. It is deduced that color centers are formed within the $WO_4^{2-}$ tetrahedra of the lattice. Such peaks were absent in an appropriately annealed crystal, indicating its enhanced radiation hardness. Relaxation processes also occur in La– and Y– doped samples, at higher temperatures when the measurement frequencies lied also in the kHz region. Evidence from impedance spectroscopy and other measurements confirm that the introduced $La^{3+}$ ions almost exclusively occupy the $Pb^{2+}$ lattice sites, whiles $Y^{3+}$ are partly substitutional and interstitial. Both kinds rare–earths doped material, if excessively annealed in oxygen, exhibited a second dielectric relaxation and showed decreased transmittance near 420 nm. PWO containing Sb gave relaxation peaks at sub–ambient temperature. $Sb^{5+}$ ions are thought to take up interstitial position, until their concentration exceeds ~ 60 ppm, when some $Sb_W^{5+}$ also exist. A systematic trend in defects structure is apparent from La to Y to Sb, and primarily determined by the charge states and ionic radii of the dopants.

# Table of Contents