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CHARACTERISTICS OF SINGLE CRYSTALS OF TETRAGONAL ARSENATES

DATA SHEET 701

CHARACTERISTICS OF SINGLE CRYSTALS OF TETRAGONAL ARSENATES

INTRODUCTION

Single crystals in this group belong to the 42m symmetry and isomorphous with KDP. There are four members, namely:

ADA:	Ammonium Dihydrogen Arsenate	$\text{NH}_4\text{H}_2\text{AsO}_4$
KDA:	Potassium Dihydrogen Arsenate	KH_2AsO_4
RDA:	Rubidium Dihydrogen Arsenate	RbH_2AsO_4
CDA:	Cesium Dihydrogen Arsenate	CsH_2AsO_4

These salts are soluble in water and single crystals are grown in a saturated solution of the salt. When these crystals are grown in heavy water (D_2O) solution, the useful electro-optical properties are enhanced. In this case hydrogen is replaced by deuterium and the new crystal, of say, CDA grown in D_2O is written as D-CDA: Cesium Dideuterium Arsenate CsD_2AsO_4 . An asterisk is sometimes used to designate the prefix D, CD*A for D-CDA.

Quantum Technology is the first company to investigate the application of Arsenate isomorphs for second harmonic generation (SHG). RDA and CDA crystals have lower birefringence and useful non-linear properties, for frequency doubling of Ruby laser and Nd:YAG laser radiation respectively. Important physical and electro-optical properties are given in Table I and Table II.

A lower temperature limit for SHG application is set by the Curie temperature. Below this temperature the crystals do not exhibit E-O effect and the antiferroelectric crystal ADA physically cracks at this temperature. The upper temperature limit is set by slow decomposition of the crystal producing a milky white film on its surface at temperatures of about $140^\circ - 150^\circ\text{C}$. For ADA crystal, it is somewhat lower, about 120°C . Resistivity of these salts depends upon metallic impurities. The temperature co-efficient of resistivity is of the order of $2.5\%/^\circ\text{C}$ and is negative. This can lead to a thermal runaway break down if voltage is applied continuously.

These crystals are transparent in the range 206nm - 1600nm (thickness 10mm). Deuteration increases the infra-red limit to 1900nm. Crystals of RDA and CDA are four times more soluble in H_2O than KDA and ADA. Therefore polished crystals of RDA and CDA should not be subjected to high (about 60%) relative humidity. Hand gloves should be used to handle optically polished crystals.

Crystal RDA can be angle tuned or temperature tuned to frequency double Ruby laser radiation with efficiency approaching 30% for a multimode beam. The acceptance angle is over 2° and the 90° phase matching temperature for RDA is about 92°C . Crystal D-CDA can be angle tuned or temperature tuned for Nd:YAG laser radiation. The 90° phase matching temperature is about 110°C . Efficiency of over 40% can be achieved for a multimode beam. For more information, please refer to data sheet 706 for angle tuning and data sheets 704 and 707 for temperature tuning.

TABLE I

PHYSICAL PROPERTIES OF TETRAGONAL ARSENATES									
MATERIAL		ADA	D-ADA	KDA	D-KDA	RDA	D-RDA	CDA	D-CDA
PARAMETER									
DENSITY gm/cm ³		23.10	-	2.868	2.890	3.315	3.333	3.43	3.45
THERMAL EXPANSION 10 ⁻⁶ /°C from -50° to +50°C	c	1.0	-	47.0	45.6	49.0	-	51.0	-
	⊥c	29.0	-	24.0	15.1	17.0	-	7.0	-
THERMAL CONDUCTIVITY W/cm/°C at 25°C		-	-	0.020	-	-	-	0.015	0.015
SPECIFIC HEAT Cal/degree C Mole at 25°C		36.0	-	30.2	-	-	-	-	31.9
RELATIVE DIELECTRIC CONSTANT AT 25°C, and at 1 KHz	K ^T ₁₁	75.0	-	53.7	70.0	54.5	71.5	58.0	74.0
	K ^T ₃₃	14.0	-	21.0	31.0	28.5	42.5	34.0	61.0
CURIE TEMPERATURE °K		215.8	-	95.6	162.0	109.9	177.8	143.3	212.0
SPECIFIC RESISITIVITY R ₃₃ ohm-cm at 25°C		2x10 ⁷	-	1x10 ⁸	3x10 ⁸	2x10 ⁷	5x10 ⁷	2x10 ⁷	5x10 ⁷
90° PHASE MATCHING WAVELENGTH (nm) and TEMPERATURE °C	20°C	583	591	598	609	684	699	1050	1034
	100°C	612	619	603	616	695	709	1078	1062

TABLE II

ELECTRO-OPTICAL PROPERTIES OF TETRAGONAL ARSENATES										
MATERIAL		ADA	D-ADA	KDA	D-KDA	RDA	D-RDA	CDA	D-CDA	
PARAMETER										
HALF-WAVE VOLTAGE V _{λ/2} KV at 546nm		7.2	2.1	6.43	3.6	5.54	3.3	3.8	2.0	
ELECTRO-OPTIC CONSTANT 10 ⁻¹² m/V at 546nm	r ^T ₄₁	33.5	81.34	+12.5	-	13.5	-	+14.8	-	
	r ^T ₆₃	-9.2	-	-10.9	-19.4	-13.	+22	-16.7	-36.6	
REFRACTIVE INDICES at VARIOUS WAVELENGTHS (nm)	410	n _o	1.598	-	1.581	1.578	1.579	1.573	1.590	1.582
		n _e	1.538	-	1.532	1.531	1.539	1.537	1.565	1.563
	480	n _o	1.586	-	1.576	1.571	1.568	1.562	1.578	1.573
		n _e	1.530	-	1.525	1.523	1.529	1.528	1.556	1.554
	550	n _o	1.581	-	1.569	1.564	1.562	1.557	1.572	1.567
		n _e	1.524	-	1.519	1.518	1.524	1.523	1.550	1.549
	590	n _o	1.577	-	1.567	1.562	1.559	1.553	1.569	1.564
		n _e	1.521	-	1.517	1.515	1.522	1.520	1.547	1.546
	650	n _o	1.573	-	1.564	1.559	1.556	1.552	1.567	1.562
		n _e	1.519	-	1.514	1.513	1.520	1.518	1.545	1.543
NON-LINEAR SUSCEPTIBILITY d ₃₆ 10 ⁻¹² m/Vat WAVELENGTHS (nm)	694.3	-	-	-	0.47	-	1.56	-	0.58	
	1060.4	-	-	-	0.52	-	-	-	-	