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Alkali Halide Crystals: Growth

To date, the growth of alkali halide single crystals has been mainly carried out from the melt. The choice of preparation method is always related to the application of the crystal. Early on, there was commercial interest in these materials for optical components, such as optical windows, because of their simplicity and their transparency over a large spectral range. A second important technological application of these crystals is scintillation counters. The growth of large-size samples of NaI(Tl) and CsI(Tl) has been continuously investigated to improve their use in detector modules that have applications in physics, medicine, and geology. These applications require bulk single crystals, which are produced commercially mainly by methods involving growth from the melt, such as the Bridgman–Stockbarger, Kyropoulos, and Czochralski techniques.

In addition to technological applications, fundamental studies of the physical properties of alkali halide crystals have had an important role in their growth. They are an outstanding example of ionic solids, which are among the simplest solids in nature. The understanding of their properties has served as a stepping stone for the study of many other types of crystals.

Until the 1950s the majority of investigators studying fundamental properties of alkali halide crystals used commercial samples. However, with increasing sophistication of the experimental studies on solid state research, it was found that impurity levels in these crystals influenced their intrinsic physical properties. Many attempts were then made to develop procedures and apparatus for purification and growth of ultrapure single crystals of alkali halides.

The advent of lasers in the 1960s placed more severe requirements on the optical and structural quality of alkali halide crystals, generating demand for crystals with low scattering centers and high crystalline perfection. The growth of such high quality samples with controlled impurity distribution was necessary for the development of color center lasers.

In conclusion, alkali halide crystals had an important position in the field of solid state physics. However, since the 1980s other more complex materials have been developed and the study of the growth of alkali halide crystals has decreased considerably. Nevertheless, because of their simplicity and low-cost preparation, they continue to be a very useful group of materials for fundamental (theoretical and experimental) studies.

1. *Properties of Alkali Halides*

The alkali halides are crystalline compounds with high stability. They contain elements from groups IA and VIIB of the periodic table, giving 20 compounds (Table 1). The alkali metals as a group are the most

Table 1
Physical properties of alkali halides.

Alkali halide	Melting temperature[a] T_m (°C)	Density, ρ (gcm^{-3}) ρ_{solid}[b]	ρ_{liquid}[b]	Vapor pressure at T_m^b (torr)
LiF	845	2.63	1.79	$< 10^{-1}$
LiCl	605	2.06	1.50	$< 10^{-1}$
LiBr	550	3.46	2.50	10^{-2}
LiI	449	3.49	—	10^{-3}
NaF	993	2.55	1.94	1
NaCl	801	2.16	1.50	$> 10^{-1}$
NaBr	747	3.20	2.2	< 1
NaI	661	3.66	2.67	10^{-1}
KF	858	2.48	1.87	< 1
KCl	770	1.98	1.53	$> 10^{-1}$
KBr	734	2.75	1.99	$> 10^{-1}$
KI	681	3.13	2.43	$> 10^{-1}$
RbF	795	3.55	2.87	
RbCl	718	2.80	2.13	
RbBr	693	3.35	2.67	10^{-1}
RbI	647	3.55	2.80	$< 10^{-1}$
CsF	682	4.11	3.61	< 1
CsCl	645	3.98	2.78	10^{-1}
CsBr	636	4.44	3.12	$< 10^{-1}$
CsI	626	4.51	3.17	$< 10^{-1}$

a Weast (1989). b Rosenberger (1972).