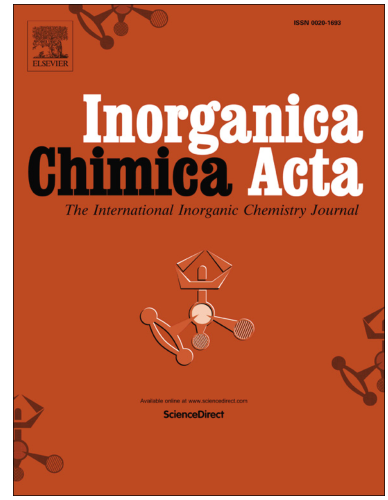

Research paper

Structural Model for Intrinsic Mechanoluminescence of Sm(III) Complex

B.V. Bukvetskii, A.G. Mirochnik, P.A. Zhikhareva

PII: S0020-1693(18)31097-1
DOI: https://doi.org/10.1016/j.ica.2018.09.010
Reference: ICA 18468

To appear in: *Inorganica Chimica Acta*

Received Date: 17 July 2018
Revised Date: 4 September 2018
Accepted Date: 4 September 2018

Structural Model for Intrinsic Mechanoluminescence of Sm(III) Complex

B.V. Bukvetskii, A.G. Mirochnik, P.A. Zhikhareva

Institute of Chemistry, Far-Eastern Branch of the Russian Academy of Sciences,
159, Prosp. 100-letiya Vladivostoka, Vladivostok 690022, Russian Federation
Fax: 007(423)2311889. E-mail: mirochnik@ich.dvo.ru

Abstract. The crystal structure of the mechanoluminescent complex [Sm(NO_3)$_3$(HMPA)$_3$] (**I**) (HMPA – hexamethylphosphotriamide) has been determined. The studies of the luminescence properties in visible and near-IR ranges are presented. On the example of the triboluminophor **I** the model and the possible mechanism of formation of intrinsic mechanoluminescence were offered and the key role of the cleavage planes was revealed. The borders and width of the destruction zone are determined by the surfaces going through the neighboring central Sm atoms in the complexes where the key process - ionization of the charged NO_3 - groups – proceeds under mechanical impact.

.

Key words: samarium(III); triboluminescence; crystal structure; cleavage planes

1. Introduction

The unique luminescent properties of rare-earth complexes (narrow emission bands, large Stokes shifts, and their long lifetimes) make them very available members to be used in the antenna units of highly sensitive mechanoluminescent sensor detectors [1-6].

Mechanoluminescent (ML) sensors are promising in view of real time (*in situ*) continuous monitoring of the size and location of damages in critical objects (dams, bridges, aircrafts, cryogenic fuel tanks for space vehicle, etc.) [7-12]. The researchers suggested various mechanisms of ML excitation in lanthanide complexes, including piezoelectric phenomena [13-19]. Cracking in such materials would lead to appearance of opposite charge on the opposite crystal surfaces at voltages high enough to allow for discharge (10^6 -10^8 V/cm). Since the ML mechanism of the lanthanide compounds is of a debatable nature, studies of the relationships between their structure and ML properties are very relevant.

If the mechanism of piezoelectricity is taken as the basis for formation of ML properties [20, 21], then by analogy with the case of mica crystals, there is a natural question about the role of cleavage planes in formation of the electrification effect. Indeed, mica has a unique cleavage, which affects many properties, including appearance of electrostatic charges on the surfaces of mica crystals in the process of their splitting [22, 23]. It is known that the mica lattice is a system of silicon-oxygen