GUIDE TO LANTHANUM FLUORIDE

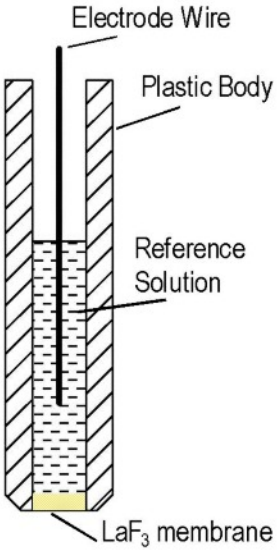
Lanthanum Fluoride crystal (LaF_3) has major use as a solid membrane electrode for manufacture into fluoride sensitive (F^{-1}) Ion-Selective probes. Unlike other crystal materials in the Crystran range, LaF_3 is not normally used for optical applications.

CRYSTAL: LaF_3 crystals are grown as nominal 10mm diameter rods. This is convenient for the ion-selective application, as it is very difficult to grow and anneal with larger diameter than this without cracking due to differing coefficients of expansion in the crystal orientations. The crystal can be grown pure but is generally doped with a nominal 0.3% Europium which gives it a yellow colour and introduces more dislocations and vacancies in the crystal lattice which aids the ionic conduction. An instance of a deliberately imperfect crystal!

The F^{-1} ions are relatively good conductors as they are much smaller than the La^{3+} ions and can move short distances between defect vacancies in the crystal lattice. Virtually all charge transfer is due to the F^{-1} ions.

Lanthanum Fluoride can be doped with Nd^{3+} and has specialist application as a scintillating material.

ELECTRODES: Typically the LaF_3 element is sealed into a rigid plastic tube with silicone rubber similar to the assembly shown. After a settling time of several minutes, equilibrium is set up between the F^{-1} ions in the surface and in the solution resulting in a charge imbalance which is dependent on the activity and concentration of the fluoride ions under test.



The response is given by the Nernst equation:

$$E = E_o + \text{slope} \times \log_{10}(\text{ion concentration})$$

The slope is theoretically about 59/n mV at 25°C where n = -1 for F^{-1} ions.

E_o is a constant which incorporates the reference potentials.

Practically, for concentrations from about 1ppm the typical potential will be given by:

$$E(mV) = 0.03 - 0.059 \log_{10}(ppm/100)$$

Typically, zero fluoride gives a potential >200mV and the slope will be 59±10mV

Typically 1ppm gives approximately 125mV and 10ppm approximately 60mV

Crystran Ltd. can only supply the shaped and polished LaF_3 crystal membranes and do not make these electrodes.

EXPERIENCE: Sometimes there can be problems in getting expected potentials and performance from LaF_3 electrodes. This is not likely to be a problem in the crystal but probably in the surface polish and preparation, or if the surface has become contaminated. It is thought the lanthanum fluoride electrode can have a surface film resembling a hydrolyzed surface. Soaking the element in 50% glacial acetic / 50% water will generally condition the surface for use. This is not a time critical operation, about 15 minutes should be sufficient. Wiping the LaF_3 tip with a little fluoride toothpaste has been reported to work too.

REFERENCES:

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