Positron analysis of right- and left-handed alanine single crystals

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Studies of the interaction of polarized light or particles (including electrons, $e^-$, or positrons, $e^+$) with asymmetric forms of matter has been of interest to scientists since the discovery of chirality and of particle physics. Researchers have been interested in $e^+$ interactions with chiral molecules for decades, but with indecisive results [e.g. 1, 2]. After reviewing the field, we speculated that the $e^+$ or positronium (Ps) might interact differently with chiral pairs of large enantiomeric single crystals—i.e. LH and RH asymmetric forms—and found significant differences in “free positron” annihilation and intensities in evaluating L and R quartz crystals [3]. To extend this line of research we crystallized large D- and L-alanine crystals and performed PALS measurements using a Na-22 positron source.

Alanine crystals were obtained via slow evaporation of water in a Dewar, or from water/acetone solvent in a temperature-controlled environment (Fig. 1). These methods resulted in small (~0.5 cm³) or large (> 1.0 cm/side) crystals, respectively. Intensity ($I_2$) results from LH and RH crystals were different in PALS analysis (e.g. Fig. 1, right). Aspects of asymmetric crystals, stereo-recognition, and stereo-selection will be discussed, as well as prior positron experiments with asymmetric forms of matter. The result here may be considered a follow-up study and extension of early work by Garay, et al. [4], Rich [5], and others over the years investigating the PAS of D- and L-amino acids.

Fig.1. Examples of large L- and D-alanine crystals. MELT analysis of PALS data for small (~0.5 cm) L- and D-alanine crystals.