Biological pyroelectrics for energy harvesting and infrared detection

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Pyroelectricity is the ability of certain non-centrosymmetric materials to generate a current when they experience a change in temperature over time; the pyroelectric current is proportional to the rate of heating or cooling. All pyroelectric materials also demonstrate piezoelectricity, the ability to generate a charge around their surface when subjected to stress (the direct effect) or conversely, to develop a mechanical strain in response to an electric field (the converse effect). A small subset of pyroelectric materials show switchable polarization, making them belonging to ferroelectric materials.

Pyroelectric detectors are thermal detectors where temperature fluctuations produce a change on the surface charge of pyroelectric crystals. The change in surface charge gives rise to a corresponding electrical signal that can be amplified, and used for temperature measurements, spectroscopy and IR thermography. This temperature gradient can be created by the absorption of light. Of the different pyroelectric materials available, triglycine sulfate, lithium tantalate and lead-zirconia titanate are the most commonly used pyroelectric detectors.

The limitations of these detector materials in relation to advanced applications [1] drive us to explore new materials of biological origin for potential performance improvement and sustainability. Pyroelectricity in biological materials are relatively less studied [2]. Notable exceptions are quantitative studies in bone and tendon [3], poled [4] and un-poled hydroxyapatite [5], γ-Glycine [6] and tear-enzyme lysozyme [7], and qualitative studies in plant leaves [8] and the thorax of live insects [9]. The coefficients of pyroelectricity in biological materials often far exceed that of conventional pyroelectric materials. This suggests that we must now evaluate the opportunity and challenges in using the newly found biological pyroelectrics for technical applications such as pyroelectric energy harvesting and infrared detection.

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