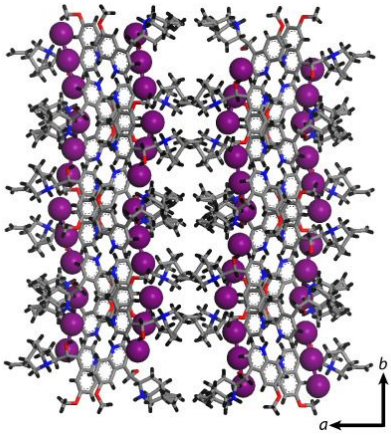
Edwin Herbert Land and Polaroid

Advanced

- **Edwin Herbert Land** (* 7. May **1909** in Bridgeport, Connecticut, USA; † 1. March **1991** in Cambridge, USA) founded the **Polaroid Corporation** in **1937**, a company known to almost everybody before the advent of digital cameras around 2000. A Polaroid camera (introduced Christmas 1948) could produce a paper picture minutes after it was taken.
  - More important to us here, he also invented the first polarizing foil. For that he relied on a discovery made earlier by the British toxicologist **William Bird Herapath**. One of his assistants (for reasons not quite clear to me) added some Iodine (**J**) to **dog piss** around **1850** and produced needle-shaped greenish crystals. Two of those crystals crossing each other at a certain angle appeared black, however. Of course we understand immediately that this is simply a "crossed polarizer" effect . Back in **1850** this was understood, too, but considered remarkable. The crystals were properly named *Herapathite* and identified as Iodine-Chininsulfate (the dogs were fed Chinin before they were allowed to go to the bathroom)
- Land managed to incorporate **Herapathite crystal** (made without the help of dogs, I hope) into plastic foils, and by stretching the whole thing to align them.
  - Since it is known *now* that Iodine additions to some polymers turn them into *conducting* polymers, some confusion arose if the polarizing mechanism depends on conducting nanorods in Lang's foils. Well, most likely not. Lang's polarizers depend on the second of our two principles.
  - Todays simple linear polarizing foils probably do not employ Herapathite any more. It is surprisingly difficult to find out exactly how they are made and work, however.
  - Anyway, the punch line is that it took about **150** years to unravel the crystal structure of Herapathite. The deed was done by chemists of the University of Seattle, details can be found in: Science 12 June 2009: Vol. 324, p. 1407 ; authors Bart Kahr, John Freudenthal, Shane Phillips and Werner Kaminsky. Here is a picture from this reference (Copyright Bart Kahr)



The crystal structure of herapathite. Iodine atoms are purple spheres. The absorbing axis is vertical. Solvent molecules and sulfate ions have been removed for clarity.

  - Well, you can almost feel that this crystal must somehow polarize light. And, maybe, those Iodine atom chains do produce some conductivity? The *question* then is if a nanorod conductor grid would still work on molecular dimensions far smaller than the wavelength?
  - Relax. If you look at the complex index of refraction, you first realize that the conductivity σ is part of it. Secondly, you realize that a herapathite crystal cannot possibly by isotropic but must carry an ϵ and thus also ***n*** *tensor* around with it - the question is moot. It's all contained in the complex index of refraction!
- There is much to be learned from that story:
  - One can become rich and famous by exploiting a material properties that are not really understood. That's what (sometimes) distinguishes pragmatic engineers from hard-core scientists.
  - There is a lot of stuff out there that is far more complex than our ubiquitous **fcc** crystals but is useful and money-making.
  - Next time you step into dog shit: don't curse but consider if it might be useful for something. As always, it's advisable to motivate graduate students to do the dirty work!