PART II: Deathnium

By Theo Hartman - GJD Contributor

In the first part of this two-part article we looked at how the characteristics of individual transistors come into play when voicing a simple fuzz face circuit. The product of the transistor gains and the capacitances between the Base and Collector electrodes produces a high-frequency roll-off due to an electric phenomenon known as the Miller Effect.

In an effect that relies as heavily upon transistor choice as the fuzz face, the final result is not only a function of the transistor gains employed but also of the transistor junction-capacitances. The presence (or absence) of capacitance within the transistors influences the eq of the signal and warmth of the fuzz.

What is the correlation between transistors of different ages and type and junction capacitance? The answer requires a peek at the evolution of how the transistor was formed.

The earliest Point-Contact transistors were extremely fragile contraptions with poor frequency response and gains of little more than 1 (unity). They involved two whisker-thin electrodes contacting a germanium crystal surface a distance of <2mm apart. This was a far cry from today’s power transistors, devices capable of handling giga-hertz frequencies or having gains into the 100’s, but the Point-Contact transistor demonstrated the principle of transconductance in a crystal lattice. From there on it was a race to develop power-handling, frequency response and gain.

Of the various methods engineers explored to form more rugged, higher-gain devices using Germanium crystal, the Alloy-Junction rose to brief prominence. Indium ingots and an Antimony-doped Germanium wafer were alloyed in an inert atmosphere. As the layered melt cooled the alloy recrystallized to form three separate regions, the Base, the Emitter, and the Collector, to which electrodes were attached. These devices were encapsulated in glass or metal cans, and while temperature sensitive, were sufficiently rugged and high enough gain for industrial and consumer use.

Frequency response was much improved, but still poor low by today’s standards. Due to unintended impurities in the Germanium crystal (beyond the desired Antimony component) and difficultly controlling precisely the depth and geometry of the intrusion of Indium into the Germanium wafer, transistor characteristics varied widely within a single batch and yield was less than optimal. Anyone who has sorted through a batch of old Germanium transistors is familiar with this phenomenon.

In a grounded-emitter transistor arrangement like the fuzz face, as small change in voltage between the Base and Emitter (your guitar signal) produces a large change in current between the Collector and Emitter. As charge-carriers attempt to cross the Germanium wafer region between the Collector and Emitter electrodes to fulfill their “current-delivery" duties they became subject to a phenomenon known as “carrier-death”.

Carrier-death is now understood to be influenced by the distance traveled (thickness) and the chemical composition of the wafer. Charge carriers—electrons or electron-voids called “holes”, would fail to make it through the wafer, becoming trapped by stray ions within the lattice. This phenomenon was poorly understood at first, however, and engineers invented the term “Deathnium” to describe the mysterious substance degrading their alloys’ performance.