



### 50 YEARS AGO

"Origin and Age of Meteorites." In his recent article under this title, Prof. H. C. Urey says: "While the excellent studies of Paneth and his co-workers are most interesting because of the facts which they present about the formation of meteorites and the effects of cosmic rays, I believe that it is very difficult to decide what event or events were recorded by the helium, uranium and thorium abundances."

We should like to put on record that we agree with Prof. Urey that there are difficulties in the interpretation of our results; but that we do not think that his statements prove that our arguments, leading to an age of no more than a few hundred million years, are incorrect. We are not convinced that his interesting thermodynamic reasoning can be applied to the calculation of the maximum quantities of uranium and thorium in iron meteorites, since it is by no means certain that their distribution was achieved under equilibrium conditions.

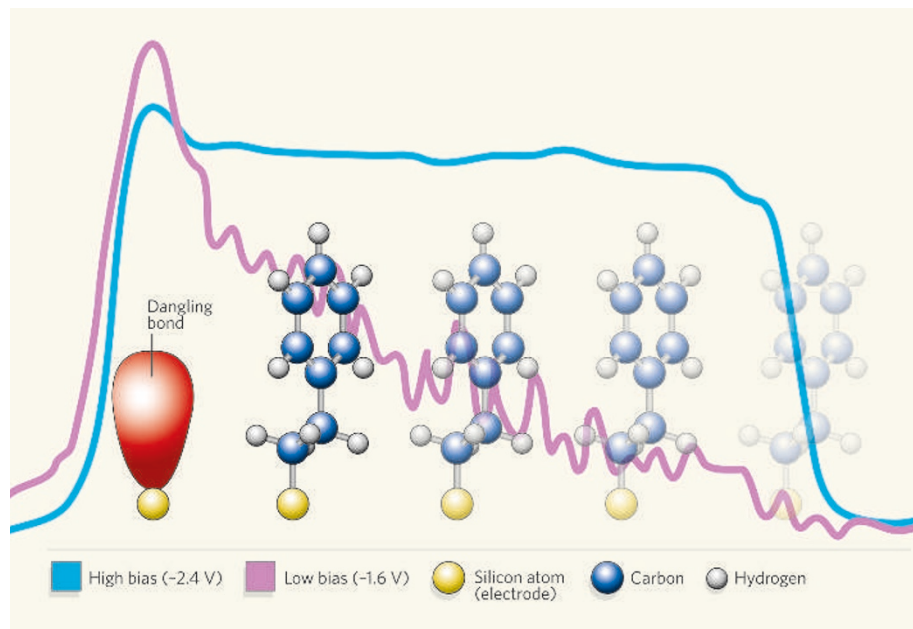
F. A. Paneth *et al.*

From *Nature* 4 June 1955.

### 100 YEARS AGO

The thirty-fifth of the privately printed opuscula... of the Sette of Odd Volumes is entitled "The Early History of the Royal Society." The author of this brochure is Mr. Henry B. Wheatley... who has succeeded in writing a very interesting account of the early years of our national association of men of science. Mr. Wheatley shows that Charles II — "Founder, Patron, and one of the Royal Society of London for improving Natural Knowledge" — took a genuine interest in the advancement of the society. "True he did not give any money, but then money was never very plentiful with His Majesty."... Objections were on one occasion made to Charles II that a member recommended by him for election was a shopkeeper. By way of reply the King "gave this particular charge to his Society, that if they found any more such tradesmen they would be sure to admit them all, without any more ado."

From *Nature* 1 June 1905.



**Figure 1 | Dangling potential.** The polymerization of a molecule (here an organic styrene-derived molecule, not to scale) on a silicon substrate stops abruptly at a dangling-bond site. The blue and purple lines indicate the height of the molecules, as seen by a scanning tunnelling microscope (STM) — a measure of the charge transport across the molecules. At higher bias (blue line), all molecules are 'turned on', and appear bright in the STM picture. At lower bias (purple line), all molecules should appear dark. Wolkow *et al.*<sup>1</sup>, however, discover that the electrostatic potential of the negatively charged dangling bond causes the nearest molecules to remain bright. This suggests that such structures could be used to manipulate charge transport through molecular junctions. (Figure adapted from Fig. 1 of ref. 1.)

the passivated electrode, leaving behind an unpaired electron that hangs free.

Wolkow and colleagues<sup>1</sup> take advantage of two remarkable properties of silicon surfaces to characterize how changes in the charge state of a silicon surface atom influence the effective field over the molecular junction. First, the 'polymerization' of the molecules — the process by which they attach themselves covalently along 'dimer rows' on the silicon surface to form a line — ends abruptly at a dangling-bond site (Fig. 1). Second, the dangling-bond site itself can become more or less charged depending on the doping level of the silicon (that is, the deficiency or excess of electrons that is induced by adding an 'impurity element' with an intrinsic number of valence electrons different from silicon's four).

Wolkow and colleagues<sup>1</sup> used a scanning-probe microscope to examine the effective charges along the length of the polymers originating from a given dangling-bond site. They found that when the dangling-bond site is charged, a 'slope' structure is seen that is absent when the site is uncharged (Fig. 1): molecules attached to the silicon electrode close to a charged dangling bond appear to stand out farther from the electrode than those at a greater distance from the dangling-bond site. Wolkow and colleagues interpret this as the effect of a local electrostatic charge on charge transport through the polymeric wire. This interpretation is supported by calculations showing changes in molecular orbital states caused by the charged dangling-bond site.

This result constitutes direct evidence that localized charges profoundly affect charge transport in single-molecule structures on silicon surfaces at room temperature.

The silicon–organic interface investigated by Wolkow and co-workers has many advantages over the more conventional metal–molecule interface (at least as the latter is usually implemented). One is the tight geometric constraint provided by a single covalent bond. Another is the bandgap character of the silicon (requiring an electron to acquire additional energy to contribute to conduction), which can be changed by doping to adjust the conductivity. This bandgap can result in useful phenomena, such as the negative differential resistance<sup>12,17</sup> (equivalent to an increase in voltage leading to a decrease in current) observed in transport through molecules bonded to dangling-bond sites.

More generally, changing the electrostatic potential on a molecule will change its conduction characteristics<sup>3,5,6,17,18</sup>. In ordinary transistor geometries, this electrostatic control is provided by one of three electrodes, the 'gate', which regulates the amount of current that can flow from 'source' to 'drain' through the main channel of the transistor. In most single-molecule transport measurements, for example using 'break junctions'<sup>9,19,20</sup>, such gating can also be attained, but it requires very large voltages. In effect, this is because the molecular entities are a long way from the gate compared with the source–drain distance. This new work suggests that more effective