Chemistry

How much do you smoke? Spit it out

Saliva levels of cotinine – a long-lasting metabolite of nicotine – provide a sensitive monitor of a person's recent smoking history, report researchers at Miriam Hospital in Providence, R.I. According to David B. Abrams, who directed the studies, saliva cotinine not only provides long-lasting evidence of smoking, but also is sensitive enough to reveal minor "cheaters" – those who claim to have abstained but in fact smoked one or two cigarettes.

In a pair of studies, Abrams and his colleagues tested 189 individuals: 30 who had not smoked for at least a year and 159 who were enrolled in smoking-cessation programs. Each subject provided two 1-milliliter samples of saliva for radioimmunoassay analysis. (This analysis uses reactions between rabbit antisera and the saliva to measure cotinine.)

Writing in the July AMERICAN JOURNAL OF PUBLIC HEALTH, the researchers report that saliva cotinine provided "perfect classification of smokers versus nonsmokers." Moreover, Abrams told SCIENCE NEWS, among persons who smoked from zero to 20 cigarettes, "there's a fairly decent linear relationship – the more cigarettes smoked, the more cotinine [measured]." Among heavier smokers, however, this correlation blurs – saliva-cotinine tends to plateau at a certain level, above which any increase is not measurable.

Until recently, serum-cotinine levels have been the "gold standard" for reliably and quantifiably confirming past-smoking status, Abrams notes. However, these tests require the drawing of blood and are unreliable for identifying those who smoked more than about two days earlier. By contrast, the new saliva tests are noninvasive and provide a smoking history that goes back at least seven days – the longest period available.

More bad news about that tasty browning

The Maillard reaction – a heat-activated chemical interaction between sugars and amino acids – is what browns the edges of cookies, the crusts of breads and the surfaces of meats. While it makes these smell and taste good, it can also reduce the presence of some amino acids (SN: 4/24/82, p.282) and the bioavailability of some proteins (SN: 6/30/84, p.410). Now researchers at the University of Parma in Italy report that Maillard reactions in meat also produce mutagens, substances that cause genetic mutations.

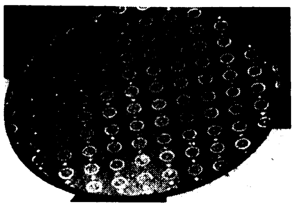
Because ribose is present in relatively high amounts in red meat, white meat and fish, and is also one of the most reactive sugars in the Maillard reaction, the Parma scientists ran products of its Maillard activity at 100°C through the Ames mutagenicity assay. In the May-June JOURNAL OF FOOD SCIENCE, they report that this sugar "forms mutagenic products with most of the amino acids normally present in meat." They suspect these mutagens, perhaps with others produced by broiling or frying, may help cause the human cancers that have been linked to eating cooked meat.

New limits for 8 organics in tapwater

The Environmental Protection Agency (EPA) has just announced final standards for the eight most prevalent volatile organic-chemical pollutants in tapwater. The new limits, which go into effect Dec. 31, 1988, involve benzene and vinyl chloride – both known human carcinogens – and several probable or possible carcinogens, such as carbon tetrachloride and trichloroethylene. While environmentalists had pushed for limits on these chemicals, many, like Jacqueline Warren of the Natural Resources Defense Council in New York City, are not satisfied with the standards. She says the vinyl chloride limit of 2 parts per billion, for example, is about 20 times higher than what EPA has suggested can be removed by activated carbon filtering – an available technology.

Technology

Raising a crop of transistors



GTE

The latest development in the world of microelectronics is almost as magical as pulling a rabbit out of a hat and potentially a lot more useful. A team of researchers at GTE Laboratories in Waltham, Mass., has succeeded in "growing" the basic components of a transistor. In effect, they let nature do the work of creating a silicon structure that can easily be turned into an electronic device. The technique circumvents much of the costly, delicate, fault-prone processing normally used to construct integrated circuits on the surfaces of silicon wafers. And, as a bonus, it produces transistors that can survive large electrical currents.

The GTE process, developed by Brian M. Ditchek, starts with a mixture of molten silicon and tantalum metal. In the liquid state, both ingredients mix completely, with tantalum spread evenly throughout the silicon. However, when the mixture is cooled and starts to solidify, it separates into two components. Each component seeks its own kind, and patches of the compound tantalum disilicide form within a silicon matrix.

To capture this structure in a useful crystal form, the researchers lower a silicon "seed" rod into the molten mixture just before it begins to solidify. When this rod is slowly drawn out of the liquid, solidification occurs at the interface between the rod and the liquid. Tantalum disilicide appears as numerous microscopic threads that run the length of the resulting crystal. The rest of the material has the orderly structure of a single crystal of silicon. The tantalum threads, about 1 micron in diameter, are, on the average, 6 microns apart.

The cylindrical crystal is then sliced into wafers, about 25 millimeters in diameter and 1 millimeter thick. Each wafer is converted into an array of transistors by laying down a set of target-shaped electrical contacts on the wafer's surface (see photograph). Each target consists of three conducting rings. Current normally flows from the bull's-eye (the current source) through the intervening silicon layer to the outer ring (the drain). That flow can be regulated by changing the charge on the inner ring (the gate), located between the source and the drain.

This particular transistor structure has the advantage of extending through the full thickness of the wafer. As a result, the GTE transistor can handle high power levels. In contrast, transistors laid down as part of integrated circuits are etched in thin films on a silicon surface. Such delicate features usually can't withstand large currents.

The GTE technique works best when tantalum makes up 2 percent by volume of the original mixture. The process fails if the initial composition is slightly different. Why this is true isn't clear yet. The whole process is somewhat mysterious, says Ditchek. Meanwhile, GTE researchers are studying combinations of silicon with other metals to see if a similar structure can be created. They are also manipulating the crystal-growth environment to find the best possible conditions for producing suitable crystals. They have discovered, for instance, that the tantalum threads are farther apart when the crystal is pulled out of its liquid bath more quickly. In laboratory tests, prototype devices have turned out to be particularly efficient in detecting light.

"Although still early in our research, we are obviously excited that we have found a significantly simpler and, we believe, cheaper way to produce an electronic device," says GTE's C. David Decker. "However, what is truly remarkable is that we've created an entirely new electronic material and device form, which may open up a spectrum of uses that can't even be imagined at this time."