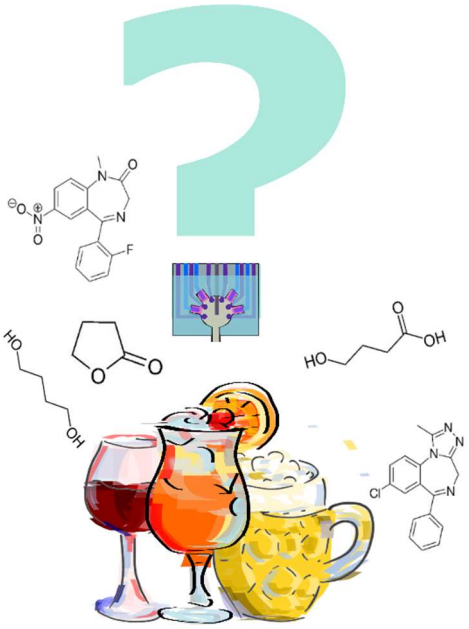
Unleashing the potential of ion-transfer voltammetry based electronic tongues for date-rape drug detection in real samples

Date-rape drugs cause sedation, amnesia, and short-term "blackouts", making people vulnerable to theft and sexual assault, including rape. The scariest part is that these substances don't have a distinct color, taste, or smell, making them almost impossible to spot. They also leave the victim's body within few hours, rendering little to no evidence. Instead of just analyzing bodily fluids and hair after something happens, we should focus on ways to prevent the crime. We need methods that let people easily see if their drink has been tampered with.

In the world of detecting illegal drugs, there are tests that change color or glow to indicate their presence. But these tests face problems because the drugs can be mixed with colorful drinks or food bits. So, usually, you need to put a small sample into another container with special chemicals to see if the drug is there. This is not practical in places like bars or clubs. Additionally the lighting is often not good enough to spot the difference. Some tests just look for a group of chemicals called amines, assuming that most illegal drugs have such a group. But that's a problem because many foods are also amines, resulting in false alarms. Other field studies found that these tests don't work well with water, juice, wine and many other drinks, in which lethal doses might not show any change at all. Regardless their true analytical value date-rape drug tests get immense publicity just as the changing color nail polish that didn't actually work and was quickly discontinued.

From an analytical point of view the problem is quite complex, there are many different molecules causing the same effect (γ-hydroxybutyric acid (GHB), γ-butyrolactone (GBL), butane-1,4-diol, and several benzodiazepines) and the samples can range from water, soda, pure spirits, to complex cocktails and food.



We can solve this intriguing problem with a high-tech sensor inspired by our sense of taste – an electronic tongue. It doesn't have taste buds like our tongue, but uses chemical sensors and an algorithm instead of our brain. After the program learns from many examples, it can test a new one and tell us if it is contaminated, or even provide numerical data and type of contamination. Electronic tongues are amazing because they can handle tricky situations, like complex samples, or presence of interfering species. Despite being around for three decades, their use is still limited because the sensors they use don't give enough information.

This project is about to change that. Instead of potentiometric sensors that give one point of unique information per sample, we are equipping our sensor array with ion-transfer voltammetry probes. With such sensors we apply a disturbance to the system usually by changing the potential between the electrodes and observe what happens. Instead of one point we get hundreds of them per sample, providing information about many different species, and their interaction with the sensor, for example through adsorption. The species do not have to be electroactive as with other electrochemical sensors. It is enough if they are charged. This greatly widens the scope of molecules that can be identified using this method, proteins, drugs, neurotransmitters. Possibilities are almost endless.

Now, here is another catch: Despite their incredible potential, ion-transfer voltammetry isn't getting the attention it deserves. The main problem is that the interface it relies on is a bit unstable and difficult to work with, which has held it back from becoming more mainstream.

In this project we will miniaturize the ion-transfer voltammetry probes, to make them easier to use and more stable, and later apply in an electronic tongue to detect different date-rape drugs in many different real samples. But that doesn't mean that protecting people from date-rape drugs will be our only achievement. After we will solve such difficult analytical problem we will know how to design other sensor arrays for complex samples and multiple analytes. This knowledge will allow us to detect pollutants in water, pesticides in our food, or even analyze important disease in body fluids.