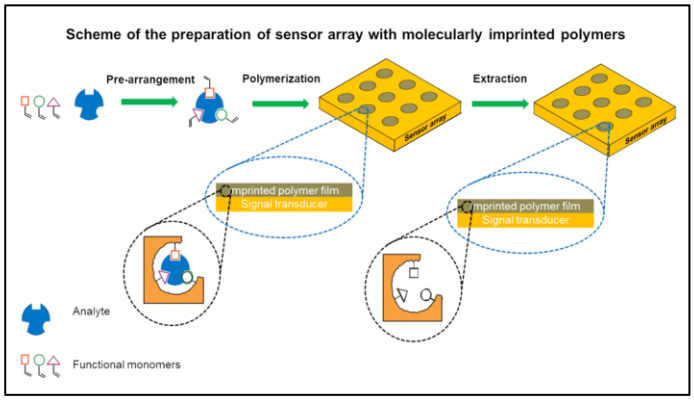
1. Project scientific goal. Food safety is one of the predominant worries in modern societies, which broadly consume highly processed food. Various additives preserve food freshness. The residues of additives used to speed up the growth of crops and livestock also may still appear in the final food product. The influence of those additives on human health is often carelessly neglected. Therefore, developing fast, cheap, and reliable analytical methods for rapid food analyses for undesired contaminants and adulterants is essential. One of the targeted foods is dairy products, especially milk. They are consumed in large quantities and are typically required to be delivered fast to consumers. Therefore, the ***Project's scientific objective*** is to establish the fundamentals, elucidate the mechanism of functioning, and develop methods for selective, fast, and easy determination of chosen dairy product contaminants. The contaminants to be tested will include substances from groups that can appear in them during (i) food production, such as growth-promoting hormones (e.g., somatotropin), antibiotics, e.g., tetracycline and amoxicillin, antiparasitic drugs, e.g., clorsulon, or other medication, and (ii) milk processing, such as salicylic acid, benzoic acid, urea, hydrogen peroxide, and even surfactants. For selective determination of those compounds, we will devise dedicated chemosensors, which we will then combine into one multi-sensing platform capable of determining several contaminants. We will use molecularly imprinted polymers (MIPs) as the recognition units of the chemosensors to afford the necessary sensitivity and selectivity. Furthermore, our "in operando" spectral and ellipsometric studies accomplished using the devised sensors will allow for a better understanding of the sensing mechanism, which is often poorly understood. The ***Project's research hypothesis*** is that our MIP chemosensors, imprinted with the chosen representative dairy product contaminants, will fulfill the unmet analytical need for fast, selective, and reliable analytical tools necessary for field determinations of the chosen food contaminants. MIP multi-sensing platforms will allow for the development of reliable methods for determining contaminants in dairy products and can be used as an effective tool in the environmental studies of the propagation of contaminants.

2. Project's research methodology. Our studies will be interdisciplinary, engaging analytical chemistry, polymer and materials science, and physical chemistry specialists. Those will be involved in fabricating MIP films, capable of selectively binding the chosen dairy products' contaminants and adulterants, that can be easily integrated with the transduction units, allowing their application as recognition elements in arrays of chemosensors operating in complex matrices. The MIP preparation procedure is presented in the included scheme. Firstly, a pre-polymerization complex is formed in solution between a template molecule and functional monomers fitted with appropriate functional groups. As the template, either the analyte itself or its close structural analog can be used. Then, the formed complex undergoes polymerization in the presence of a cross-linking monomer. That way, a polymer network is formed with template molecules embedded in it. Removal of the template molecules vacates molecular cavities with sizes and shapes that match those of the template molecules. Then, the MIP thus prepared is capable of selective binding of analyte molecules.



In our Project, we will apply the above procedure to devise arrays of selective chemosensors for the dairy product contaminants and adulterants chosen from representative classes. For that, we will use a range of monomers bearing suitable functional groups and capable of electrochemical polymerization (such as carbazole, thiophene, pyrrole, or aniline). Extensive "in silico" modeling will help design monomers capable of effectively binding the analytes, thus forming selective MIPs. We will also use computer modeling to search for the most suitable epitopes for protein analytes' imprinting. Then, we will integrate the devised and fabricated MIPs by electrochemical polymerization with multi-sensor platforms using extended-gate field-effect transistors (EG-FETs) and electrochemical transduction techniques. An important part of the Project will be "in operando" studies of the MIP film chemical and structural changes, which can elucidate the sensing mechanism of those films, which is often insufficiently understood. Finally, we will test the analytical parameters of the devised multi-sensor platforms (sensitivity, detectability, selectivity, etc.).

3. Expected impact of the research accomplished. The positive Project outcome will strongly influence the development of MIP-based tools in analytical chemistry, especially environmental analysis and food quality control. Combining computer modeling with experimental verification will facilitate rational MIP devising. Our "in operando" studies of the EG-FET electric and electrochemical transduction mechanisms in MIP chemosensors, coupled with fabricating MIPs with controlled properties, will enable rational devising chemosensors tuned to the needs. Project implementation will advance the knowledge of the possibility of MIPs' application for food product analysis in the presence of interferences in complex matrices like milk.