Hydrazone Molecular Switches for Multicolor Magnetic Resonance Imaging

Department of Organic Chemical Technology and Petrochemistry, Faculty of Chemistry, Silesian University of Technology, Krzywoustego 4, 44-100 Gliwice

Modern medical diagnostics uses techniques such as computed tomography, ultrasonography or magnetic resonance imaging. They belong to the domain of so-called imaging diagnostics, the result of which is a three-dimensional image of the examined part or the whole body. Magnetic resonance imaging is a non-invasive soft tissue diagnostic technique with excellent spatial resolution, which usually uses the magnetic properties of the nucleus ^{1}H. Due to the fact that soft tissues contain large amounts of water, it is usually difficult to distinguish individual tissues or detect pathological changes. A variety of contrast agents are used to improve the quality of images. The structure of these substances depends on the method of imaging. In the case of magnetic resonance imaging, contrast agents are most often metal complexes with magnetic properties. They work by acting on neighboring water molecules, which results in a lighter or darker image in this area. Due to the accumulation of a contrast medium or a difference in concentrations in individual tissues, image quality is improved.

Currently, the possibility of selective imaging of selected phenomena at the cellular level and not only anatomical changes is also being sought. For this purpose, however, it is necessary to design contrast agents that would be active only in the presence of a selected enzyme or, for example, in a selected pH range characteristic of cancerous lesions. Contrast agents based on fluorine nuclei are useful for this purpose. This is due to the high sensitivity of fluoride detection in magnetic resonance imaging, which allows for practical applications in medical diagnostics.

As part of this project, research will be carried out on obtaining fluorine contrast agents sensitive to external stimuli. They will have the character of a molecular switch sensitive to pH changes. The principle of operation of the switch itself is that it has two isomeric forms with different geometries, which pass one into the other in a specific pH range.

The research will include the preparation of model contrast media. The use of computational methods will be helpful in this regard. This will allow us to select the most promising structures, which will then be obtained in the amount needed to assess their properties in practice. The influence of the structure on the pH range in which a given contrast medium is activated or deactivated will be important here. In the second stage of the research, the structure of the contrast medium will be optimized in terms of image quality obtained by magnetic resonance imaging by selecting the appropriate multi-color imaging procedure.

Additional function groups will be introduced if necessary. This will allow us to optimize the operation of such contrast media by improving their solubility, durability, increasing the difference in properties in both possible states or controlling the pH range in which the switch occurs. The results of the project will be twofold. On the one hand, knowledge about the design of contrast media based on molecular switches will be increased. To date, only a few such structures have been developed, mainly sensitive to the presence of metal ions. The results of the project will therefore be valuable from the point of view of creating new contrast agents for medical diagnostics, which may contribute to progress in medicine and more effective diagnosis of some diseases, especially cancer.