Metal Doped Carbon Dots (CDs) - preparation and properties

Carbon dots (CDs) are extremely small carbon-based particles that are able to emit light when exposed to certain wavelengths. Accidentally discovered in 2004, they quickly attracted the attention of scientists around the world. Thanks to their properties—such as fluorescence, non-toxicity, biocompatibility, and ease of modification—they have potential applications in many fields: from medicine and diagnostics, through environmental protection, to modern optoelectronic technologies.

The aim of the project is to develop simple, eco-friendly, and low-cost methods for synthesizing carbon dots from food industry waste (e.g., flour production residues). Instead of expensive and high-purity reagents, easily accessible waste materials will be used, aligning with the principles of sustainable development. Using food industry by-products instead of edible materials helps avoid ethical and environmental concerns related to competition for food resources. Moreover, this approach supports the circular economy by reducing organic waste and giving it added value.

The project also involves modifying the structure of carbon dots using organic salts containing various metals, such as nickel, zinc, or palladium. Such doping can significantly alter the optical and chemical properties of the materials—for example, increasing fluorescence intensity, changing color, improving stability, or introducing new functionalities such as catalytic activity or magnetic properties. Preliminary studies have shown that some modifications can even triple the fluorescence intensity.

The project will help answer how different metals affect the structure and properties of carbon dots and which modifications are the most effective. Statistical analyses will also be conducted to better understand the relationships between synthesis conditions and the properties of the final material.

The expected outcome of the project is the development of new, biodegradable, and biocompatible nanomaterials that could be used as dyes, sensors, drug carriers, or materials for medical imaging. The project makes a valuable contribution to the development of green chemistry and modern materials science, while promoting the use of waste as a valuable resource.