

*The influence of the conditions of synthesis and modification
with metals on the structure and photocatalytic properties
of graphitic carbon nitride*

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Abstract of the dissertation

This doctoral dissertation entitled "The influence of the conditions of synthesis and modification with metals on the structure and photocatalytic properties of graphitic carbon nitride" presents the well-known, graphitic carbon nitride in a new version. Starting from the characteristics of carbon nitride, through catalytic systems, and ending with the etching of this polymer by metal particles, the dissertation discovers the potential of this inconspicuous substance.

Graphitic carbon nitride is a layered polymer, structured from carbon-nitrogen rings. Obtained in a one-step synthesis from melamine, dicyandiamide or urea, this polymer has a wide range of applications. It is known mainly as a photocatalyst and as a support of active phases, but also as a carrier of drugs or nanomaterial used in capacitors.

This dissertation covers research described in four scientific publications and one patent. It begins with a discussion of the influence of various synthesis conditions (type of precursor, synthesis temperature, rate of temperature rise and time of condensation) on the physicochemical properties and photocatalytic activity of carbon nitride - included in the first publication **D1** (*Materials*, 2020, 13, 2756). After optimization of the synthesis conditions and the selection of those leading to the obtaining of carbon nitride with the highest specific surface area, its photocatalytic activity in the photodecomposition reaction of water to hydrogen was determined. The consequence of the earlier work is the second publication of the series **D2** (*Materials*, 2022, 15, 710), describing the physicochemical properties and photocatalytic activity of systems composed of metal deposited on previously obtained carbon nitride.

During the preparation of the first work, the interpretation of XPS spectra of carbon nitride was unclear. The XPS method is important for the characterization of carbon nitride. In the literature, the assignment of bands corresponding to specific bonds in the structure varies, which results in misleading conclusions. Moreover, the XRD method is also controversial. The third publication **D3** (*Dalton Transactions*, 2020, 49, 12805-12813) is a digression on the topic of the inconsistency in the interpretation of the research results obtained with this method. During experimental tests, the syntheses of metal/carbon nitride were carried out in a wider temperature range than for typical metal catalysts (typically up to ~ 400 ° C). During the conducted experiments, surprising values of the specific surface area of the reduced systems were obtained in the temperature range of 475°C - 550°C - the specific surface area of the systems drastically increases after reduction. The astonishing phenomenon, called for the dissertation "etching" of carbon nitride, leading to the formation of spongy graphitic carbon nitride was patented and included in the cycle of achievements constituting the doctoral dissertation **D4** (*A method of synthesis of carbon nitride with a high specific surface*, patent number: 240935 application date: August 14, 2018, patent publication date: July 4, 2022). Using combined techniques such as TPR-MS, TPR-FTIR, XPS research and theoretical considerations, an attempt was made to explain the process of etching carbon nitride by ruthenium and platinum, and the obtained results were included in another publication **D5** (*Journal of Materials Science*, 2022, published online on August 24 .2022 r.).