Lignin is underutilized and the bulk of produced lignin (representing about 70 million metric tons per year) is only employed as a combustible material for its high heat value. Due to its high aromatic content, lignin has great potential to function as an alternative to non-renewable fossil resources, for the production of important aromatic fine chemicals, for instance, for the pharmaceutical and food industries. Future methods of lignin-based compounds valorization must be based on new materials and green technological approaches just because the existing methods don't meet the necessary environmental and economic requirements. The goal of this project is building up, through a strict selection, **new research group** which will be focused on the **synthesis of novel multicomponent nanophotocatalytic thin layers** supported on the **internal walls of a fluidic microreactor**, the study of their activity in the **selective photo-oxidation of lignin-based model molecules** and the correlation of their performances with the composition, surface morphology and distribution of the active sites (Fig. 1).

Fig. 1 Project concept

In this project will be used new procedures for the synthesis of nanostructured photocatalytic layers inside of a microreactor using **ultrasounds** as a **green energy source** in nanotechnology and nanoengineering (Fig.2). It will be carried out the study of the physicochemical properties of **mono- and bimetallic semiconductor thin layers materials** and testing them in lignin model compounds selective photocatalytic oxidation (in a liquid-phase microfluidic space) as a **promising method of lignin-based molecules valorization**. A systematic basic research of the effect of green and unconventional source of ultrasonic energy on **low-temperature synthesis of photocatalysts** supported on the surface of the internal walls of selected polymeric microtubes will be carried out. The modification of these materials using different metals will improve selective oxidation properties and performances of the final hybrid materials in the **visible light**, what improves the utilization of solar energy. The whole spectrum of basic kinetic studies and photocatalysts' stability/recycling studies will be carried out.

Various methods are available for the preparation of thin layers photocatalysts. Nevertheless, the **benefits derived from preparing materials through unconventional approaches are very attractive from the green chemistry point of view**. Recent advances in nanomaterials synthesis have been led by the development of new synthetic procedures that allow control over size, morphology and nanostructure. The use of ultrasound-based procedures offers a facile, versatile synthetic tool for the preparation of nanofotocatalysts often inaccessible through conventional methods. Ultrasound methods make use of the physical phenomena associated with acoustic cavitation and compared to other methods, sonochemical processes have been less explored and optimized.

Fig. 2 Ultrasound-based method to synthesize photocatalytic thin layers.

A positive outcome of the proposed project has the potential of strong influencing on the field of **new materials synthesis, nanoengineering and clean/effective chemicals production**.[1] Therefore, the final outcome of the proposal will lead to **profound benefits to humanity** in the long term. These pioneering studies will permit us to understand and optimize (a) the interaction within the hybrid thin layers components on the internal surface of microfluidic reactor, and thus (b) predict surface changes manipulated by the full control of ultrasound effects during thin layers synthesis, what will result in (c) activity/selectivity/stability improvement of promising catalysts working thanks to solar light utilization which **open the possibilities for better ways of management and valorization of lignin-containing organic wastes**. The uniqueness of this project rests on a combined approach of understanding/design/synthesis of an effective semiconductor-based photocatalytic layer with optimized composition and the advantages of working in a fluidic microspace for the valorization of lignin-based model compounds. To our best knowledge, this kind of complex approach has not been yet investigated.

[1] http://www.tvn24.pl/wiadomosci-z-kraju,3/alternatywy-dla-benzyny-sok-a-moze-mleko,198000.html, http://www.sciencedaily.com/releases/2013/10/131017080116.htm, http://www.focus.pl/technika/slonce-i-fotokatalizatory-oczyszcza-brudna-wode-tanio-i-szybko-10428, http://phys.org/news/2015-07-plantations-nanorods-carpets-graphene-capture.html, http://naukawpolsce.pap.pl/aktualnosci/news,405816,plantacje-nanopretow-na-dywanach-grafenu-przechwyca-energie-slonca.html