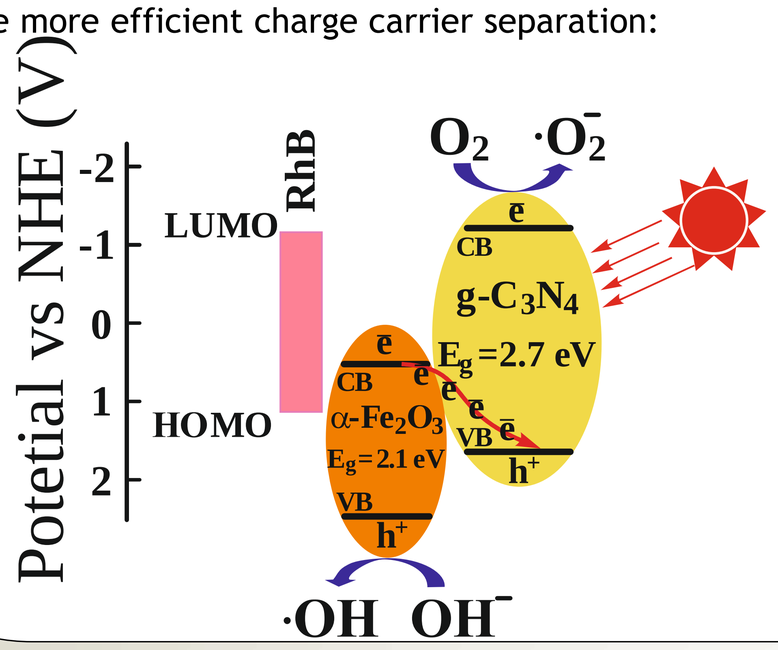
Synthesis and photocatalytic properties of nanocomposites Fe_2O_3/C_3N_4 under UV and visible light

Bikyashev E.A.
Southern Federal University, Rostov-on-Don, Russia
E-mail: eabikyashev@yandex.ru

Introduction

Fe_2O_3/C_3N_4 heterostructures are actively studied as potential photocatalysts for the decomposition of organic impurities and antibiotics, as well as for hydrogen generation or CO_2 reduction [1, 2]. In this case, either multiple heat treatments are often used, or homogenization/dispersion of the components is carried out using non-aqueous solutions, ultrasonic baths, and hydrothermal procedures. This usually limits the range of compositions of the studied materials. In addition, there are conflicting data on the effect of pH on their photocatalytic activity [3, 4]. Fe2O3/C3N4 heterostructures enable more efficient charge carrier separation:

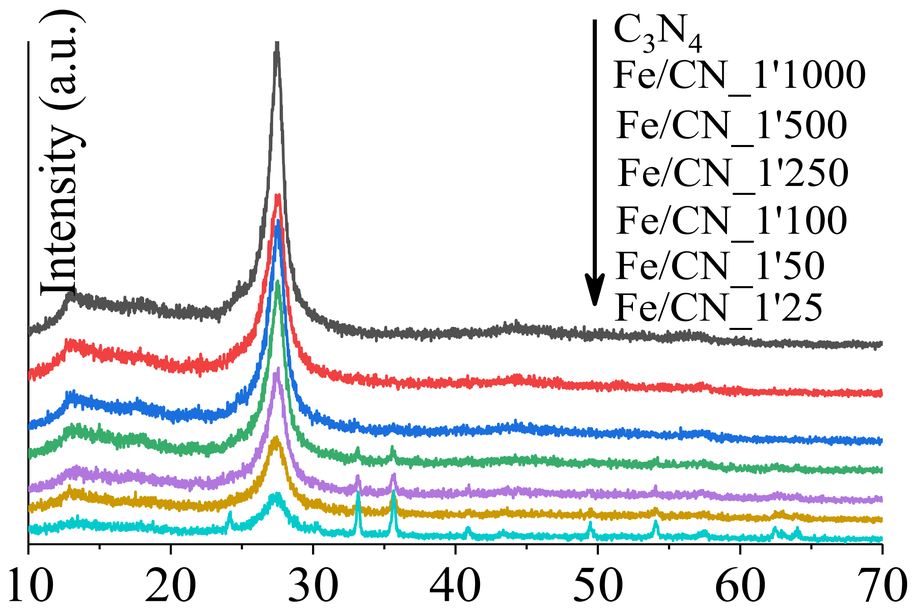


Synthesis

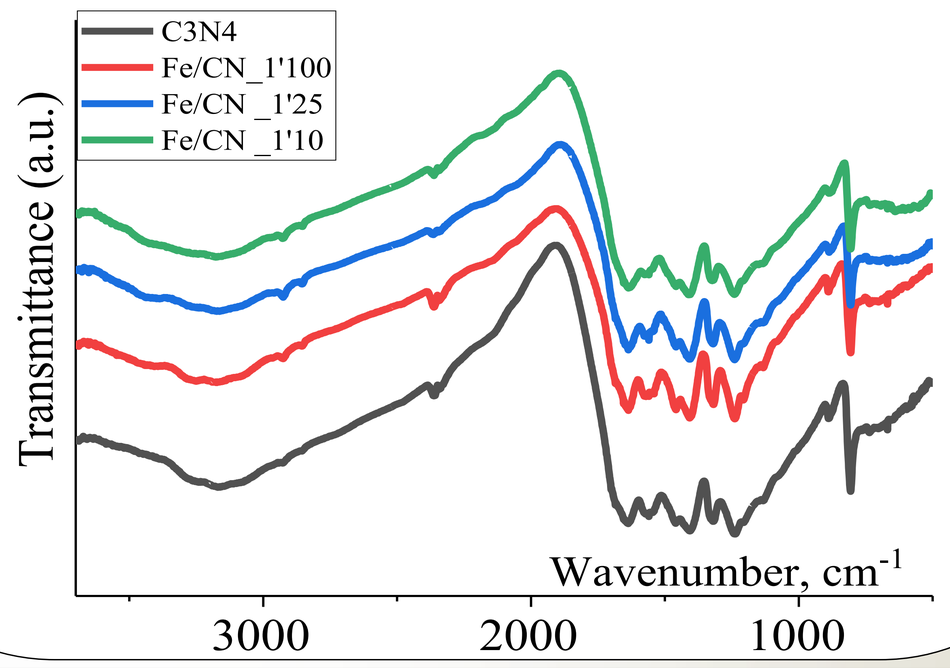
In this work, $Fe(NO_3)_3 \cdot 9H_2O$ and melamine in molar ratios from 1/1000 to 1/25 were used as precursors for the synthesis of the phases of interest and their compositing (hereinafter the symbols Fe/CN_1'1000, Fe/CN_1'250 etc. are used for brevity).
The precursors were homogenized on a magnetic stirrer with the addition of a small volume of water. After drying, the mixtures were subjected to a single 4-hour calcination at 550°C in closed crucibles, the furnace heating rate was 5°C/min. For comparison, unmodified C_3N_4 was obtained under similar conditions.

Characterization

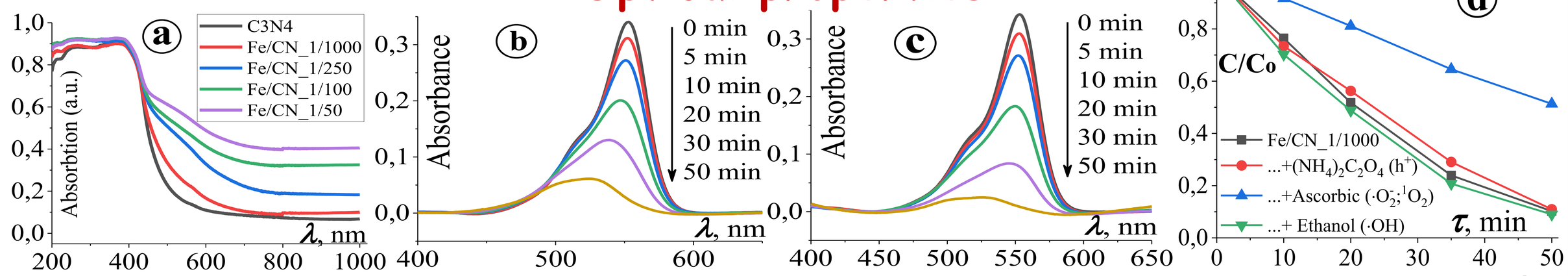
According to X-ray diffraction data (Fig. 1), α-Fe_2O_3 is reliably detected in most Fe-containing materials (beginning with Fe/CN_1'100), which indicates the formation of macroscopic clusters of this phase.



The FT-IR spectra show a number of peaks in the range 1240-1640 cm-1, which are attributed to the C-N and C-N bonds. A sharp peak at 811 cm-1 and a broad peak centered at 3160 cm-1 correspond to the normal vibration of the triazine structure and to the N-H and O-H stretching vibrations, respectively.



Optical properties



Diffuse absorption spectra of some of the investigated phases (***a***), transformation of the absorption spectral line of RhB in the presence of C_3N_4 (***b***) and Fe/CN_1'1000 (**c**). Figure (***d***) shows the C/C_0 ratio versus irradiation time for the photocatalytic decomposition of RhB into Fe/CN_1'10000 under UV light: without any absorber and in the presence of ammonium oxalate, ascorbic acid and ethanol.

Conclusions

1. A wide range of α-Fe2O3/g-C3N4 composite materials has been obtained, their crystal and local structure, and optical absorption have been studied.
2. It is shown that the material Fe/CN_1'1000 has an increased photocatalytic activity with respect to the degradation of rhodamine B in the UV and visible range.
3. In the visible range, a high rate of rhodamine degradation is provided in an acidic medium, which may be due to the retention of NH/NH2 amino groups in the triazine structure of C_3N_4 nitride.