

FMR and photocatalytic investigations of nFe-TiO₂ (n=1%, 5% and 10%) compounds

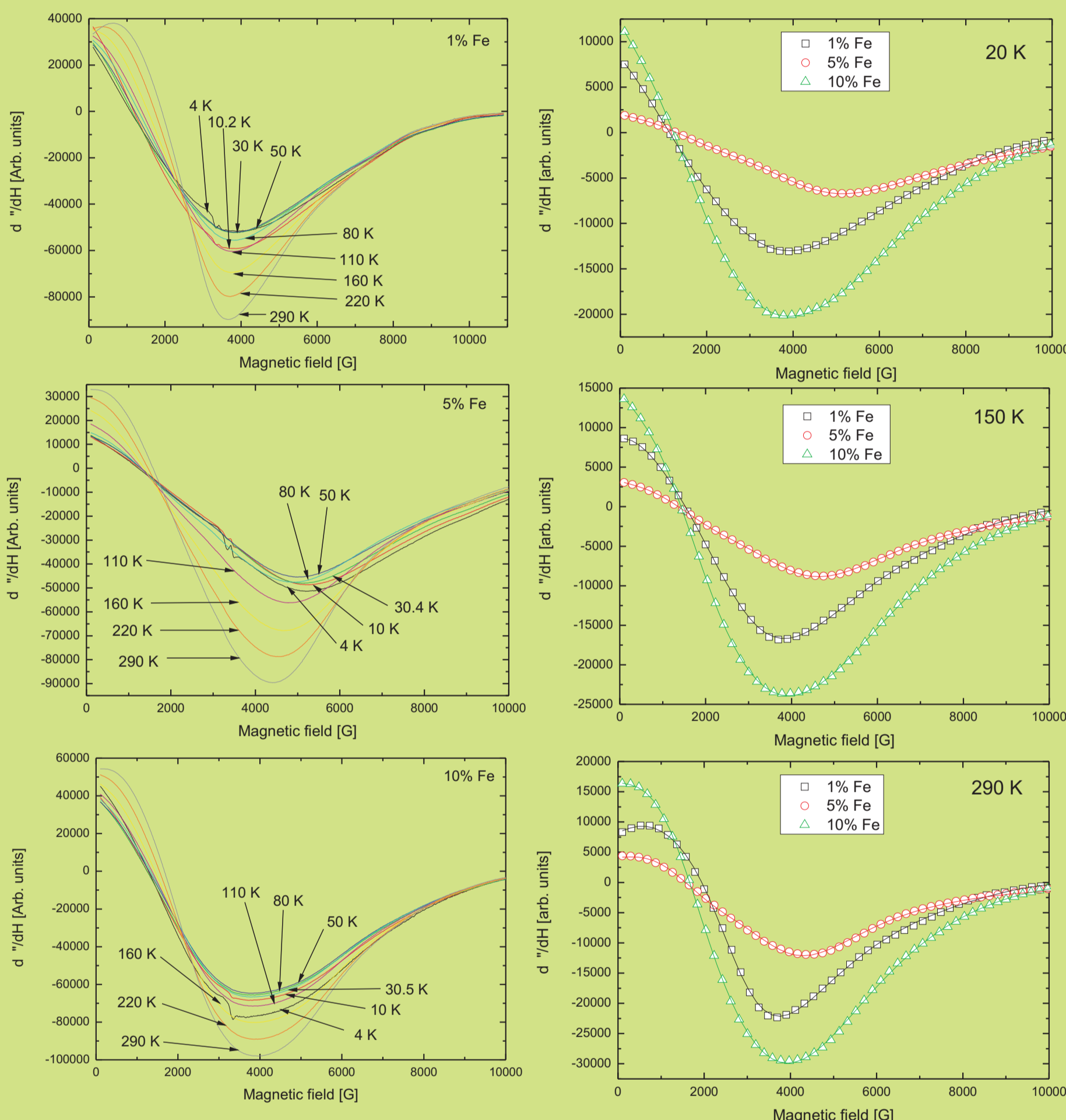
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Some of the registered FMR spectra at different temperatures of 1 Fe,N-TiO₂/800, 5 Fe,N-TiO₂/800, 10 Fe,N-TiO₂/800 samples.

Experimental (symbol) and fitted (solid line) spectra of unit mass samples, at three selected temperatures. Spectra of samples 1 Fe,N-TiO₂/800 and 10 Fe,N-TiO₂/800 were fitted with three Callen-shape components, while sample 5 Fe,N-TiO₂/800 was fitted with two Callen-shape component.

Conclusions

- The FMR spectra have been satisfactorily fitted with the Callen-type lineshape components: two components in case of n=5% sample and three components for n=1% and 10% samples.
- The anisotropy field is the biggest in n=10% sample ($B_a \sim 14$ kG), smaller in n=1% sample ($B_a \sim 10$ kG) and the smallest in n=5% ($B_a \sim 5$ kG).
- The integrated intensity follows the same tendency as the anisotropy field: the smallest is for n=5% sample, the largest for n=10% sample.
- The photocatalytic activity follows the reverse tendency of the anisotropy field and the integrated intensity: sample n=5% showed the biggest activity, sample n=10% the smallest photocatalytic activity.

Aim of the work

To determine the magnetic properties of the investigated samples and to correlate them with photocatalytic activity.

Samples preparation

Water suspension of a commercial amorphous titanium dioxide (TiO₂/A) from sulfate technology supplied by "Chemical Factory Police S.A." (Poland) was used as a starting material for the synthesis of (Fe,N)-co-modified rutile TiO₂ photocatalysts. Fe(NO₃)₃·9H₂O was used as a source of iron and ammonia (NH₃) (Messer, 99.85%) was used during the preparation process carried out in the furnace.

A defined amount of TiO₂ water suspension, containing ca. 35wt.% of titanium dioxide and ca. 8 wt.% of residual sulfuric acid as related to TiO₂ content, was introduced into a beaker containing aqueous solution of Fe(NO₃)₃ and stirred for 48h. The amount of Fe introduced to the beaker was of 1 wt.%, 5 wt.% or 10 wt.% relatively to TiO₂ content. After water evaporation, the samples were dried at 80 °C for 24 h in an oven. Subsequently, the material was calcined at 800 °C in NH₃ flow (co-modified samples denoted as XFe,N-TiO₂/800).

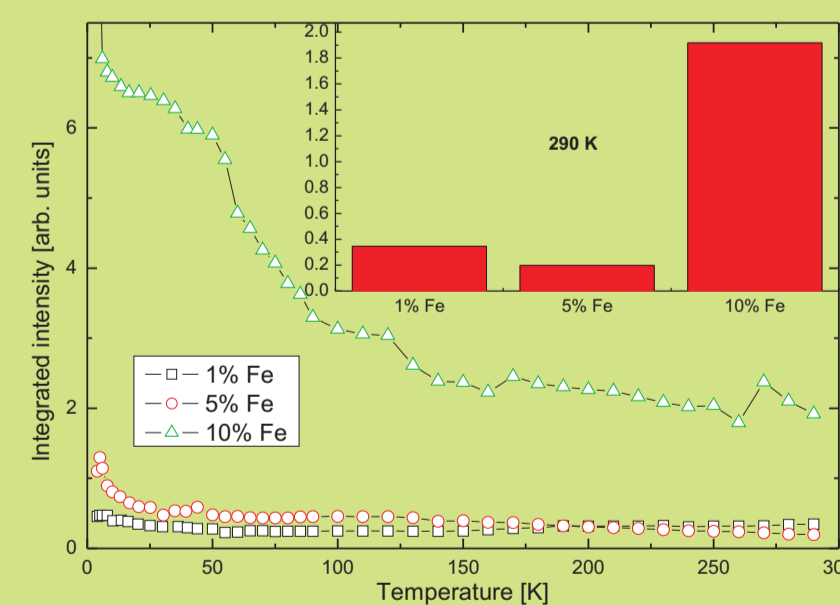
Apparatus

Magnetic resonance spectra were registered on BRUKER E500 X-band (9.4 GHz) spectrometer equipped with Oxford helium flow cryostat enabling measurements in 4-300 K temperature range.

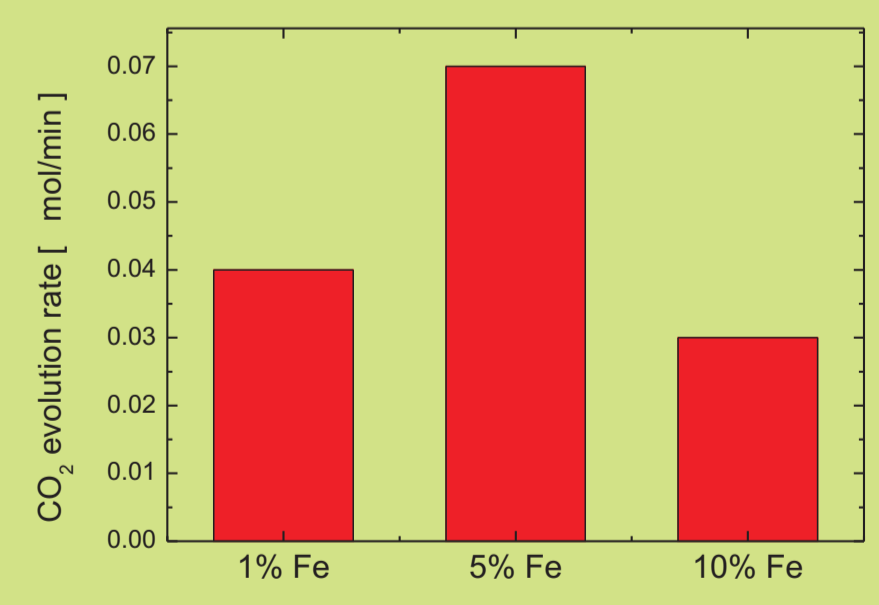
The Callen-lineshape

$$I(H) = \frac{H_0^2 H_0^2}{H H_0^2 H_0^2} \frac{H^2}{|H|_B} \frac{2H_0 |H|}{H_0 B^2} \frac{H_0^2 H_0^2}{|H|_B H_0 B} \frac{H^2}{H_0 B^2} \frac{H^2}{|H|_B H_0 B} \frac{H^2}{H_0 B^2}$$

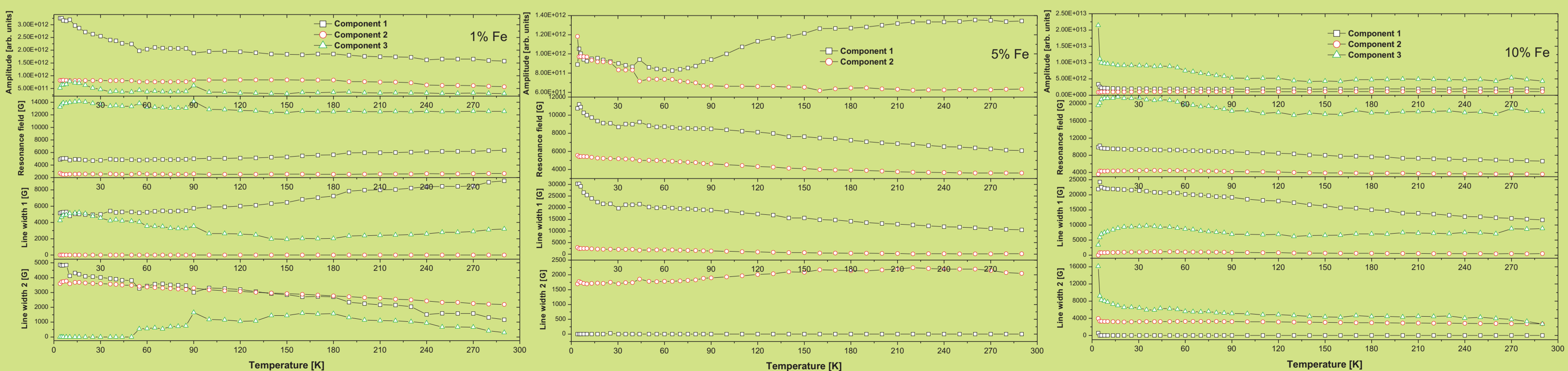
where H_0 is the true resonance field, Δ_1 is the true linewidth connected with relaxation of the Landau-Lifshitz type, and δ_H a true linewidth connected with relaxation of the Bloch-Bloembergen type.



Temperature dependence of the integrated intensity. The inset shows the integrated intensities of all three samples at RT.



CO₂ photocatalytic evolution during acetic acid decomposition under mercury lamp in the presence of Fe,N-co-modified TiO₂



Temperature dependence of calculated parameters obtained from fitting the FMR spectra with Callen-shape components.