Effect of annealing on magnetic resonance spectra of Ti-Si-C-N sample

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Abstract

Two nanocrystalline (TiC_x + SiC)/C samples have been prepared by non-hydrolytic sol-gel method. The second sample was subjected to additional annealing in NH_3 atmosphere at 1623 K. The XRD measurements showed the presence of aggregates of cubic SiC+TiC nanoparticles (10 to 30 nm in size). In both samples a very narrow electron paramagnetic resonance (EPR) line arising from magnetic localized centers was centered at g_{eff} ~2 (the differences in the resonance fields of both samples were 0.6 Gs). At T=130 K the linewidths ΔH_{pp}=1.41(2) Gs and ΔH_{pp}=2.92(2) Gs were registered for samples without and with thermal annealing, respectively. For the non-annealed sample the resonance line could be fitted by Lorentzian line in the high temperature range and by Dysonian line below 70 K. This indicates on an essential change of the electrical conductivity of this sample. For annealed sample the resonance lineshape was Dysonian in the whole investigated temperature range. Thus, the thermal annealing process could improve significantly the transport properties. An analysis of temperature dependence of the EPR parameters (g-factor, linewidth, integrated intensity) has shown that the thermal annealing process essential influenced the reorientation process of the localized magnetic centers.

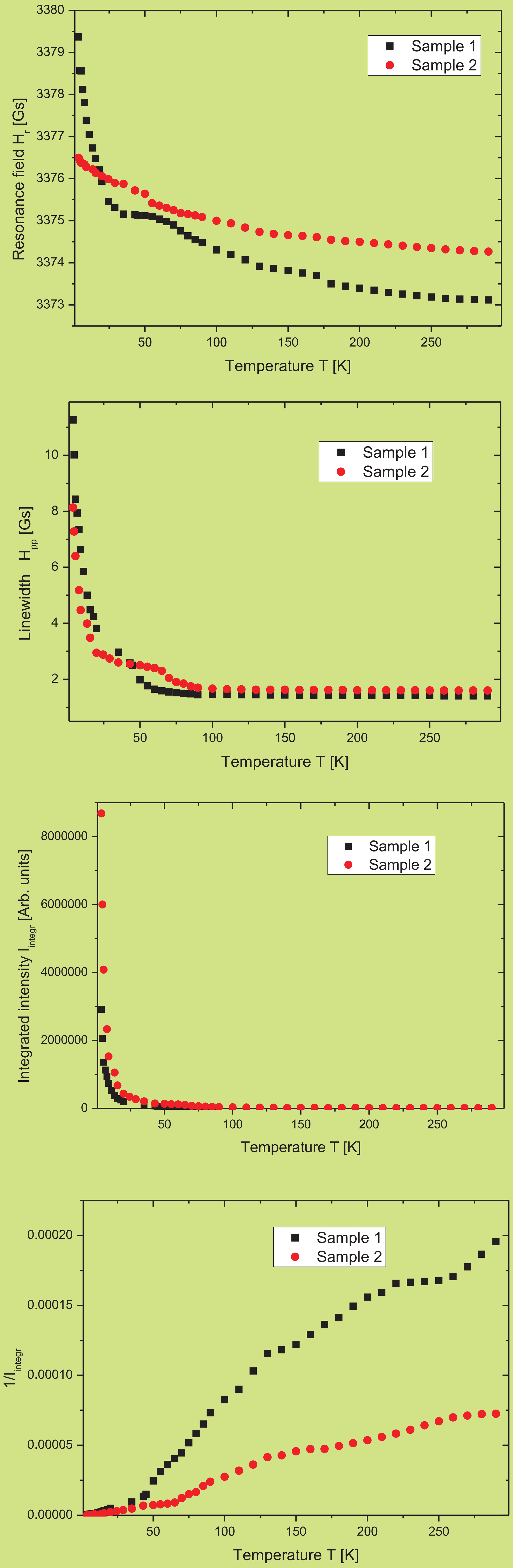

Figure 2. Temperature dependence of the EPR parameters of Ti-Si-C-N sample (resonance field, linewidth, integrated intensity, reciprocal of integrated intensity): before annealing (sample 1) and after high-temperature annealing (sample 2).

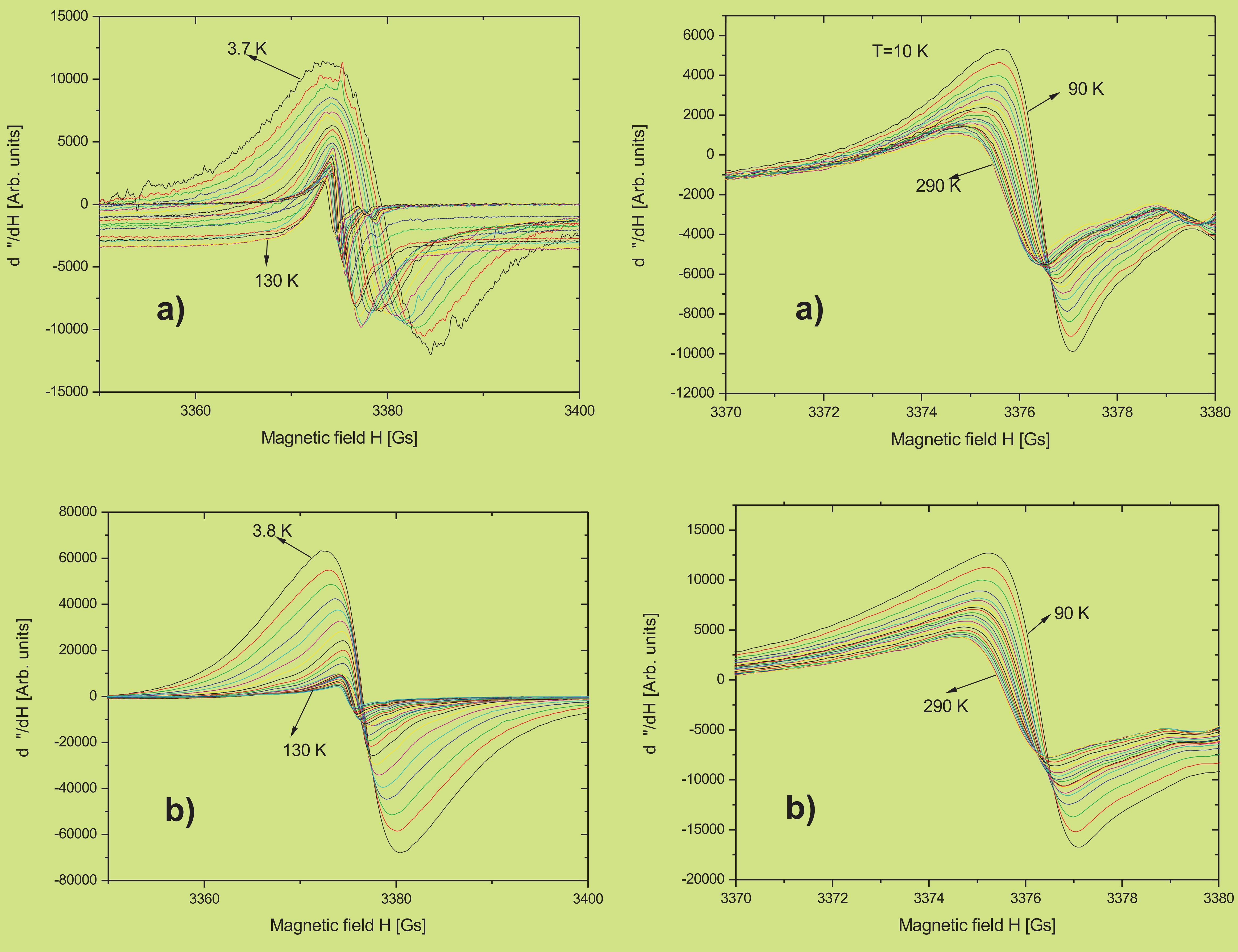

Figure 1. EPR spectra of Ti-Si-C-N sample at different temperatures: before annealing (a) and after high-temperature annealing (b). The left panels show the spectra in the low-temperature range, the right panels in the high-temperature range.