

Cathodoluminescence Read-Out of the Structural Phase of Gallium Nanoparticles

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Abstract: We report on a method of phase identification of gallium nanoparticles via their cathodoluminescence when excited by a scanning electron beam. This feature can be used for high-density phase change memory elements.

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We report that the structural phase of gallium nanoparticles can be switched by optical excitation and read via their cathodoluminescence (CL) when excited by a scanning electron beam. This opens a new paradigm in developing high-density phase change optical memory elements.

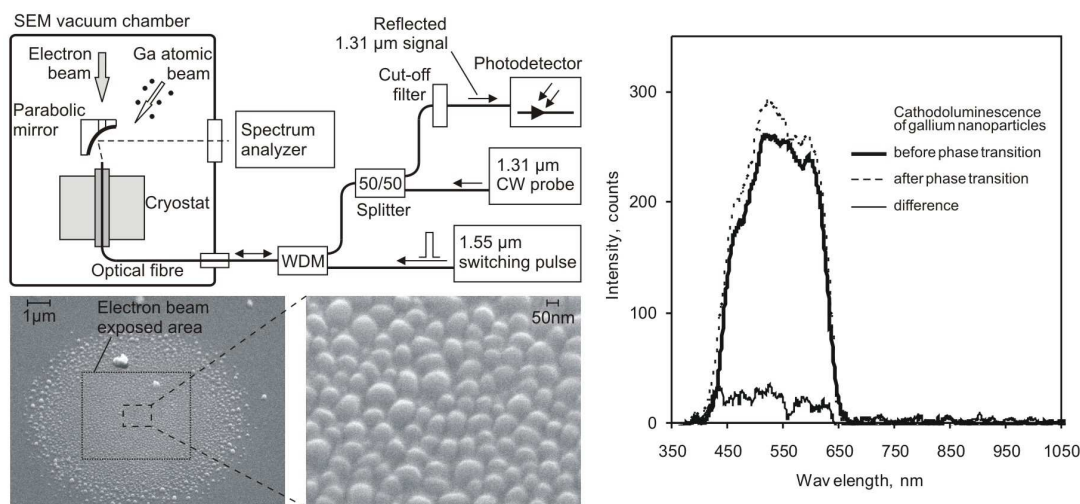


Figure 1. The experimental setup (left, top), sample (left, bottom), and measured CL spectra (right).

A film of gallium nanoparticles was sputtered at the end face of an optical fiber, through which the reflectivity at 195 K was monitored by a 1.31 μm laser (Fig. 1). By launching a single pulse from a 1.55 μm laser (17 mW, 1 μs) to the sample, a solid-to-liquid phase transition [1] was observed as an immediate change of reflectivity from 10.0 to 10.5 %. CL spectra were measured immediately before and after the phase transition. The spectra show that gallium nanoparticles luminesce in the range of 400-650 nm, in which there is a 10 % difference of emission before and after the phase transition, due to a difference in optical properties [2]. In future continuation of this first demonstration of electron beam read-out of the phase of nanoparticles, it is likely that the electron beam itself can change the phase of individual nanoparticles in the film, and that this phase furthermore can be read out at lower power by its cathode luminescence response with the same electron beam.

References

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- [2] O. Hunderi and R. Ryberg, *J. Phys. F: Metal Phys.* **4**, 2096 (1974).