Photoluminescence of porous silicon tunable by magnetic metal deposition

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In this framework luminescent porous silicon (PSi) is filled with a magnetic metal (e.g. Ni) to influence the photoluminescence (PL) by these deposits which happens in two ways. On the one hand the surface plasmon of the metal deposits is exploited to modify the luminescence [1] and on the other hand it is influenced by an external magnetic field. Due to the metal filling of the PSi the PL is blue-shifted and furthermore an increase of the intensity is observed. First the optical properties of the luminescent PSi are investigated, second Ni is deposited within the PSi samples and subsequently the nanocomposite specimens are characterized optically again and also magnetically. The optical properties are investigated with respect to the shift of the photoluminescence due to the metal filling. PL spectra of bare PSi show a maximum around 620 nm whereas in the case of Ni filled samples the peak is blue-shifted to around 580 nm and the luminescence intensity is increased.

Concerning the magnetic properties of the nanocomposite the embedded Ni structures can be superparamagnetic from the size of the pore diameters but due to the branched morphology the achieved deposits tend to be interconnected and thus do not offer necessarily a superparamagnetic behavior. Field dependent magnetization measurements performed with the magnetic field applied perpendicular and parallel to the sample surface show a high magnetic anisotropy. The coercivity of the samples strongly depends on the metal deposition time which determines the amount of metal and thus the degree of interconnections. It can be clearly seen that the samples offer a film-like behavior due to the interconnected Ni structures which is represented by the easy axis parallel to the surface (figure 1).

The optical characterization of luminescent PSi with respect to its PL compared with Ni filled samples is discussed in detail as well as the corresponding magnetic properties of the nanocomposites. Furthermore the influence of an external magnetic field on the optical properties is elucidated. The presented systems are promising candidates for applications in optoelectronics and also for magneto optical integrated devices.

[1] S. Gardelis, V. Gianneta, A.G. Nassiopoulou, Journal of Luminescence 170, 281 (2016).

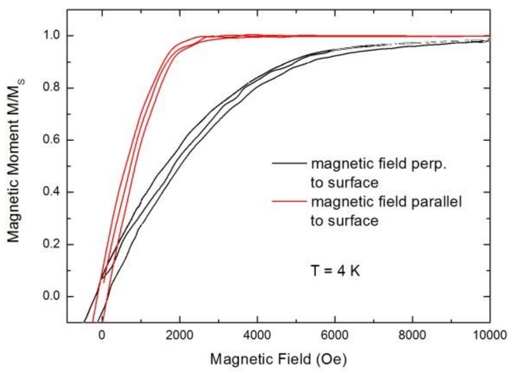

Figure 1. Magnetic measurements performed with an applied magnetic field parallel (red curve) and perpendicular (black curve) to the sample surface, respectively.