Anisotropic Photoinduced Magnetism of $Rb_iCo_j[Fe(CN)_6]_k \cdot nH_2O$ thin films*†

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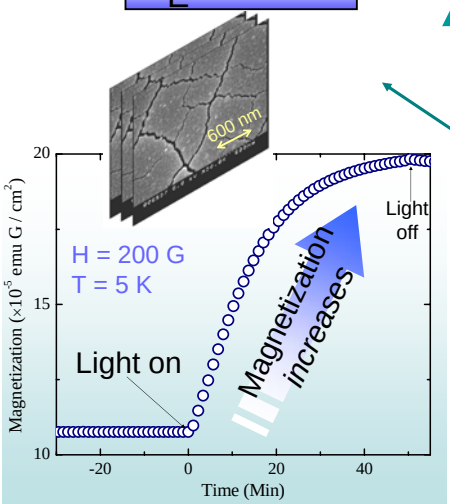
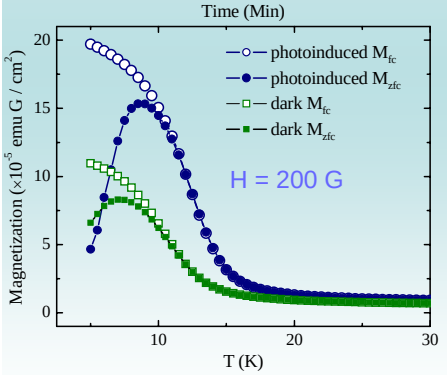
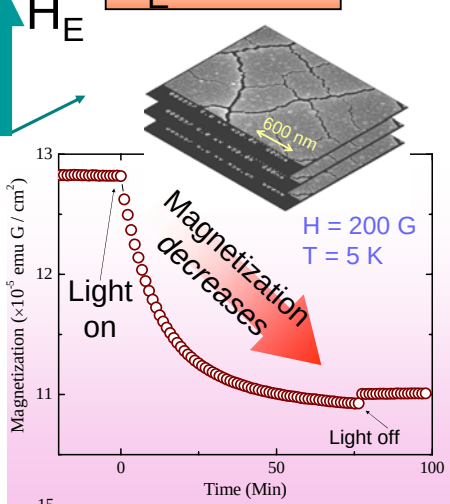
H_E // films

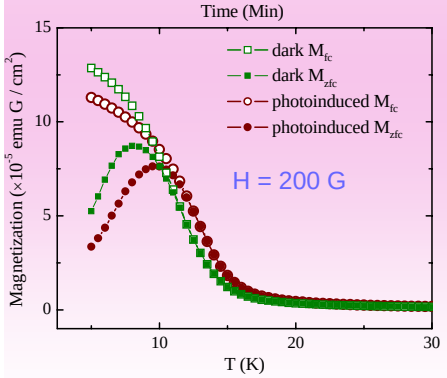




H_E

$H_E \perp$ films





In the photoinduced states, increases in T_c and the temperature T_{max}, where the zfc magnetization reaches maximum value can be described within the framework of cluster spin glasses. More specifically, the photoinduced spin creation has increased the density of larger clusters, where the magnetic correlation length is longer and more spins interact with each other, resulting in increases of T_c and T_{max} .

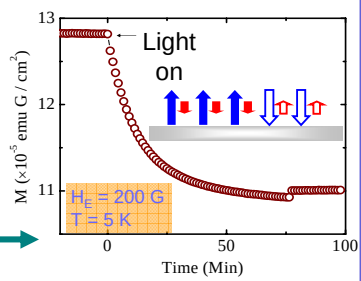
Abstract

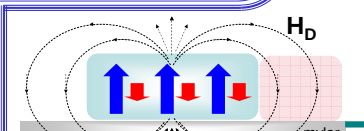
A magneto-optically active thin film of $Rb_iCo_j[Fe(CN)_6]_k \cdot nH_2O$ has been prepared using a sequential assembly method. Upon irradiation with light and at 5 K, the net magnetization of the film increased when the surface of the film was oriented parallel to the external magnetic field of 200 G. However, when the surface of the film was perpendicular to the field, the net magnetization ***decreased*** upon irradiation. The presence of dipolar fields and the low-dimensional nature of the system are used to describe the orientation dependence of the photoinduced magnetization. The ability to increase or decrease the photoinduced magnetization by changing the orientation of the system with respect to the field is a new phenomenon that may be useful in future device applications.

Model / Result

Notation key:

- Primordial Co^{II} (S = 3/2)
- **Photoinduced** Co^{II} (S = 3/2)
- Primordial Fe^{III} (S = 1/2)
- **Photoinduced** Fe^{III} (S = 1/2)
- H_D = dipolar field
- H_E = External magnetic field
- H_N = net magnetic field **adjacent** to the primordial ferrimagnetic site

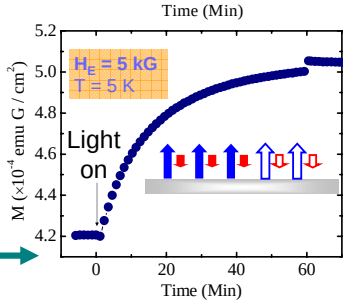


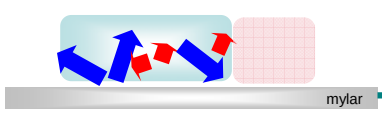


ferrimagnetic (dark, *below* T_C, dipolar fields, and $H_E \perp$ film)

$H_E < H_D$

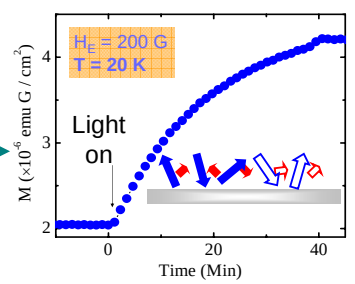
$H_E > H_D$





paramagnetic (dark, *above* T_C, **NO** dipolar fields, and $H_E \perp$ film)

$T > T_c$



Before irradiation, the solid-state compound $Rb_iCo_j[Fe(CN)_6]_k \cdot nH_2O$ develops a mixture of diamagnetic and ferrimagnetic sites upon cooling below T_c ~ 15 K. In this dark state, the diamagnetic sites contain low spin (LS) Fe^{II} (S = 0) and Co^{III} (LS, S = 0) pairs, and the ferrimagnetic sites consist of antiferromagnetically coupled Fe^{III} (LS, S = 1/2) and high spin (HS) Co^{II} (S = 3/2) pairs. Upon irradiation, there is a charge transfer within a diamagnetic site from Fe^{II} (LS, S = 0) to Co^{III}(LS, S = 0), resulting in a ferrimagnetic site with Fe^{III} (LS, S = 1/2) and Co^{II} (HS, S = 3/2). ***This photoinduced charge transfer increases the relative population of ferrimagnetic sites.*** When the film form of $Rb_iCo_j[Fe(CN)_6]_k \cdot nH_2O$ is placed in an external magnetic field (H_E) perpendicular to the film surface, there are dipolar fields produced by ferrimagnetic sites in the dark state below T_c. These dipolar fields point antiparallel to the H_E when they are seen by the adjacent diamagnetic sites. As a consequence, the net magnetic field seen by the diamagnetic sites is a vector sum of the dipolar field and H_E. Upon irradiation, the diamagnetic state undergoes a transition to a ferrimagnetic state and the orientations of the newly formed ferrimagnetic sites will follow the net magnetic field. If the dipolar field is stronger than H_E, the newly formed ferrimagnetic sites will point antiparallel to the H_E, and thus yield a ***decrease*** in the net magnetization upon irradiation.

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