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研究課題名(和文) 複合スピン機能と柔軟な有機機能を併せ持つ超分子的磁性体の合成開発とその評価

研究課題名(英文) Development of supramolecular magnetic materials based on hetero-spin systems and soft materials

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研究成果の概要(和文)：(1)サーモクロミック有機磁性体：基底三重項ピラジカル化合物群が、逐次構造相転移を示し、反磁性から $S = 1/2$ 常磁性、 $S = 1$ 常磁性となることを明らかにした。一つの誘導体で、幅広い温度領域で $S = 1/2$ 常磁性を示すものを見いだした。(2)分子包接誘起磁性体：ラジカル置換ホスト分子を合成開発した。金属イオンの有無に従って、開いた構造から閉じた構造に変化し、ホスト分子が基底三重項から基底一重項へスイッチする例を見いだした。(3)有機ラジカル配位磁性材料：4f-3d、4f-2p 系単分子磁石を合成し、ヘテロスピン間の交換相互作用を決定した。ラジカル希土類錯体自体が類例の少ない物質群である。

研究成果の概要(英文)：(1) Thermo-chromic organic magnetic materials: A series of ground triplet compounds showed successive structural phase transitions, and each phase was characterized to be $S = 0$, $1/2$, or 1 spin state.

(2) Paramagnetic host-guest compounds: Biradical host compounds were synthesized. The ground spin state was switched between the $S = 0$ and 1 states on adding or removing diamagnetic guest ions.

(3) Radical-coordinated lanthanide complexes: 4f-3d and 4f-2p Hetero-spin systems are prepared, and the exchange coupling among the hetero-spins were precisely determined.

研究分野：化学

科研費の分科・細目：複合化学・機能物質化学

キーワード：分子性磁性体 集積型金属作体 超分子科学 単分子磁石 高スピン分子 相転移

1. 研究開始当初の背景

分子を基調とする新規磁性体の中から、メモリー、表示材料、磁気抵抗、マルチフェロイクスなどの複合機能性材料への応用発展性を示すことは今後のエレクトロニクスのために重要である。一方で、分子性材料が無機物質では考えられなかったような特性も有することから、「分子性物質ならではの」という性質の導入も必要である。我々はこれまでに有機無機の区別なく、4f, 3d, 2p スピンを組み合わせて研究を進めてきた。本課題ではこのような複合スピ系に、柔軟性、加工性、反応性、光吸収などの有機由来・分子由来の機能を導入し具体化する。

2. 研究の目的

具体的には、環境応答型磁石、可溶化磁石、光応答性電導体、誘電性磁性体、電導性磁性体を目指した合成開発を目指した。物性物理側からのアプローチとして、極低温、高磁場、中性子弾性散乱の研究者とも協力して新素材の物性解析も進めた。

3. 研究の方法

メンバーは申請代表者と、研究協力者小金山造博士、連携研究者岡澤厚助教である。物質の合成開発、物性測定、理論解析を行う。各種分光法による同定、結晶構造解析も自前で行った。具体的には、(1) ホストゲスト磁性錯体の詳細な物理化学の精査と pH 依存 / 電場応答 / イオン・分子包接磁性体などの開発、(2) 光スイッチ磁気デバイス材料の開発、(3) 伝導性磁性体の開発・可溶化磁石の提案と材料の薄膜化、(4) 物理グループとの共同研究の展開を推進した。本学では、現有する大型設備に比較的恵まれている。複合機能材料戦略にも対応する。光磁気機能測定に対しては光導入オプション付き SQUID を用いた。

4. 研究成果

(1)サーモクロミック有機磁性体：基底三重項ピラジカルの一連化合物群が、逐次構造相転移を示し、反磁性から $S = 1/2$ 常磁性、続いて $S = 1$ 常磁性となることを明らかにした。この一つの誘導体で、幅広い温度領域で $S = 1/2$ 常磁性を示すものを見いだした。
(2)分子包接誘起磁性体：ラジカル置換のホスト分子を合成開発した。金属イオンの有無に従って、開いた構造から閉じた構造に変化し、ピラジカルホスト分子が基底三重項から基底一重項へスイッチする例を見いだした。
(3)有機ラジカル配位磁性材料：4f-3d、4f-2p 系単分子磁石を合成開発し、ヘテロスピ間の交換相互作用を決定した。ラジカル希土類錯体自体が、類例の少ない物質群である。

5. 主な発表論文等

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〔図書〕(計1件)

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