

Sintesis dan karakterisasi senyawa koordinasi inti ganda krom(III)-polipiridil dengan ligan gugus jembatan 4,4'-bipiridin dan pyrazin = Synthesis and characterization of polynuclear coordination compounds of chrom(III)-polypiridyls with bridging ligands of 4,4'-bipyridine and pyrazine

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Abstrak

Telah dilakukan penelitian tentang sintesis senyawa koordinasi inti ganda krom(III)-polipiridil dengan ligan gugus jembatan 4,4'-bipiridin dan pyrazin (L'). Ligan polipiridil yang digunakan adalah 1,10-phenantrolin dan 2,2'-bipiridin (L). Sintesis dilakukan berdasarkan penentuan stoikiometri antara krom(III)-ligan polipiridil-ligan gugus jembatan secara spektrofotometri.

Berdasarkan penentuan stoikiometri, diperoleh perbandingan mol krom(III):L=1:3, yang berarti bahwa rumus molekul senyawa koordinasi krom(III)-L adalah $[\text{CrL}_3]^{3+}$. Senyawa koordinasi ini berstruktur rang oktahedral yang mengandung enam ikatan koordinasi antara atom-atom N pada ligan L dengan ion krom(III).

Senyawa koordinasi $[\text{CrL}_2\text{L}'_2]^{3+}$ disintesis melalui substitusi 4,4'-bipiridin dan pyrazin pada $[\text{CrL}_3]^{3+}$. Formula tersebut mempunyai perbandingan mol krom(III):L:L'=1:2:2 yang diperoleh melalui penentuan stoikiometri. Berdasarkan perbandingan stoikiometri ini selanjutnya disintesis senyawa koordinasi $[\text{Cr}(\text{phen})_2(\text{bpy}')_2]^{3+}$, $[\text{Cr}(\text{phen})_2(\text{pyz})_2]^{3+}$, $[\text{Cr}(\text{bpy})_2(\text{bpy}')_2]^{3+}$, $[\text{Cr}(\text{bpy})_2(\text{pyz})_2]^{3+}$

Senyawa koordinasi $[\text{CrL}_2\text{L}'_2]^{3+}$ terbentuk melalui tahapan pembentukan senyawa $[\text{CrL}_2(\text{H}_2\text{O})\text{L}']^{3+}$ dengan perbandingan mol krom(III):L:L'=1:2:1 yang cukup stabil. Hal ini mengindikasikan bahwa ligan gugus jembatan terikat pada ion krom(III) melalui satu sisi koordinasi, sedangkan sisi koordinasi yang lain masih bebas. Sisi koordinasi yang masih bebas ini mampu mengikat ion krom(III) lainnya sehingga terbentuklah senyawa koordinasi inti ganda.

Senyawa koordinasi inti ganda krom(III) - ligan polipiridil - ligan gugus jembatan disintesis berdasarkan perbandingan mol krom (III):L:L'=2:4:1 ($[\text{L}_2(\text{H}_2\text{O})\text{CrL}'\text{Cr}(\text{H}_2\text{O})\text{L}_2]^{6+}$). Senyawa koordinasi yang disintesis adalah $[(\text{phen})_2(\text{H}_2\text{O})\text{Cr}(\text{bpy}')\text{Cr}(\text{H}_2\text{O})(\text{phen})_2]^{6+}$, $[(\text{phen})_2(\text{H}_2\text{O})\text{Cr}(\text{pyz})\text{Cr}(\text{H}_2\text{O})(\text{phen})_2]^{6+}$, $[(\text{bpy})_2(\text{H}_2\text{O})\text{Cr}(\text{bpy}')\text{Cr}(\text{H}_2\text{O})(\text{bpy})_2]^{6+}$, dan $[(\text{bpy})_2(\text{H}_2\text{O})\text{Cr}(\text{pyz})\text{Cr}(\text{H}_2\text{O})(\text{bpy})_2]^{6+}$.

Karakterisasi senyawa koordinasi hasil sintesis ($[\text{CrL}_3]^{3+}$, $[\text{CrL}_2\text{L}'_2]^{3+}$ dan $[\text{L}_2(\text{H}_2\text{O})\text{CrL}'_2\text{Cr}(\text{H}_2\text{O})\text{L}_2]^{6+}$ di daerah ultraungu dekat-tampak menunjukkan adanya transisi elektronik dari $4A_{2g}$ à $4T_{2g}$ $4A_{2g}$ à a_4T_{1g} dan $4A_{2g}$ à b_4T_{1g} . Hal ini mengindikasikan adanya transisi d-d.

Dari spektrum IR yang diperoleh dapat disimpulkan adanya substitusi ligan gugus jembatan pada senyawa koordinasi $[\text{CrL}_3]^{3+}$ mengakibatkan pergeseran puncak serapan. Adanya puncak baru di daerah 400-450 cm^{-1} mengindikasikan adanya vibrasi M-N yang berarti senyawa koordinasi telah terbentuk.

Pola difraksi sinar-X pada senyawa koordinasi hasil sintesis menunjukkan sudut 2 θ dan intensitas maksimum yang berbeda satu sama lain. Hal ini menunjukkan adanya perbedaan bidang-bidang hal dalam kristal senyawa-senyawa koordinasi tersebut.

<hr><i>Synthesis and characterization of polynuclear coordination compounds of chrom(III)-polypiridyls with bridging ligands of 4,4'-bipyridine and pyrazine;Synthesis and characterization of polynuclear

coordination compounds of chrom(III)-polypyridyls with bridging ligands of 4,4'-bipyridine and pyrazine. Polynuclear coordination compounds of chrom(III)-polypyridyls with bridging ligands of 4,4'-bipyridine and pyrazine (l') have been synthesized using 1,10-phenanthroline and 2,2'-bipyridine (L). The compounds were prepared based on the stoichiometry between chrom(III)-polypyridyls-bridging ligands determined by spectra photometry.

The mole ratio of chrom(III):polypyridyls ligands was 1:3 which means that the formula of the chrom(III)-polypyridyls coordination compounds were $[\text{CrL}_3]^{3+}$. The compounds have octahedral structure with six coordination bond which was formed through the N atoms of the L ligands.

The coordination compounds $[\text{CrL}_2\text{L}'_2]^{3+}$ were synthesized by substitution of bridging ligands 4,4'-bipyridine and pyrazine on $[\text{CrL}_3]^{3+}$. This formula was determined by the stoichiometry of chrom(III):L:L'=1:2:2. Based on these results coordination compounds of $[\text{Cr}(\text{phen})_2(\text{bpy}'\text{h})]^{3+}$.

$[\text{Cr}(\text{phen})_2(\text{pyz})_2]^{3+}$, $[\text{Cr}(\text{bpy})_2(\text{bpy}'\text{h})]^{3+}$, $[\text{Cr}(\text{bpyh}(\text{pyz})_2)]^{3+}$ were synthesized. The coordination compounds $[\text{CrL}_2\text{L}'_2]^{3+}$ were formed through the formation step of stable compound $[\text{CrL}_2\{\text{H}_2\text{O}\}\text{L}']^{3+}$ using mole ratio of chrom(III):L:L'=1:2:1. This results showed that the bridging ligands coordinated chrom(III) ion only on one side, while the other side was able to coordinate with another chrom(III) ion to form the polynuclear coordination compounds.

The polynuclear compounds chrom(III)-polypyridyl ligands-bridging ligands were synthesized with mole ratio chrom(III):L:L':::2:4:1 $[\text{L}_2(\text{H}_2\text{O})\text{CrL}'\text{Cr}(\text{H}_2\text{O})\text{Li}]^{3+}$. The compounds were

$[(\text{phen})_2(\text{H}_2\text{O})\text{Cr}(\text{pyz})\text{Cr}(\text{H}_2\text{O})(\text{phen})_2]^{8+}$, $[(\text{bpy})_2(\text{H}_2\text{O})\text{Cr}(\text{pyz})\text{Cr}(\text{H}_2\text{O})(\text{bpy})_2]^{6+}$.

$[(\text{phen})_2(\text{H}_2\text{O})\text{Cr}(\text{bpy}')\text{Cr}(\text{H}_2\text{O})(\text{phen})_2]^{6+}$, $[(\text{bpy})_2\{\text{H}_2\text{O}\}\text{Cr}(\text{bpy}')\text{Cr}(\text{H}_2\text{O})(\text{bpy})_2]^{6+}$, Characterization of synthesized coordination compounds $[\text{Cr}_4]^{3+}$, $[\text{CrL}_2\text{L}'_2]^{3+}$, and $[\text{L}_2(\text{H}_2\text{O})\text{CrL}'\text{Cr}(\text{H}_2\text{O})\text{L}_2]^{3+}$ using UV-VIS spectrum showed the electronic transition $4A_{2g} \rightarrow 7E_g$, $4A_{2g} \rightarrow 7A_{1g}$, $4A_{2g} \rightarrow 7B_{1g}$. This result indicates the d-d transition.

From the IR-Spectra, it can be concluded that the substitution of the bridging ligands on to $[\text{Cr}_4]^{3+}$ causes peak shift. The formation of a new peak at 400-450 cm^{-1} were related to M-N vibration which means the coordination compounds were formed. X-ray diffraction studies of the synthesized coordination compounds show different 2θ angles and the maximum intensities. This result indicates the difference in the hkl planes on the crystals.