

圖目錄

Fig. 3.1. Experimental flowchart of nickel sorption using RH and RHA from NiSO ₄ aqueous solution or nickel-containing plating wastewater.....	3-9
Fig. 3.2. Experimental flowchart for thermal treatment of nickel-containing RH samples that have sorbed Ni(II) from NiSO ₄ aqueous solution.....	3-10
Fig. 3.3. Experiment flowchart for thermal treatment of Ni(II)-containing RH samples that have sorbed Ni(II) from nickel plating wastewater.....	3-11
Fig. 4.1. Ion chromatography analysis of Ni-containing plating wastewater for F ⁻ , Cl ⁻ , Br ⁻ , NO ₃ ⁻ , PO ₄ ²⁻ , SO ₄ ²⁻	4-8
Fig. 4.2. Isotherms of Ni (II) adsorption onto RH from NiSO ₄ aqueous solution (A) and from plating wastewater(B).....	4-18
Fig. 4.3. Isotherms of Ni (II) adsorption onto RHA from NiSO ₄ aqueous solution (A) and from plating wastewater(B).....	4-19
Fig. 4.4. Langmuir adsorption isotherms for nickel-sorbing RH and RHA samples.	4-21
Fig. 4.5. Freundlich adsorption isotherms for nickel-sorbing RH and RHA samples.	4-22
Fig. 4.6. ¹³ C-NMR spectra of raw RH and the RH samples that sorb nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24h.....	4-23
Fig. 4.7. XANES spectra and their first derivative spectra of reference nickel compounds.....	4-24
Fig. 4.8. XANES spectra and their first derivative spectra of NiSO ₄ reference and the RH samples that sorb nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24h.....	4-25
Fig. 4.9. XANES spectra and their first derivative spectra of Ni(OH) ₂ reference and	

the RHA samples that sorb nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24 h.....	4-26
Fig. 4.10. Fourier transforms of EXAFS spectra of the RH and RHA samples that sorb nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24 h.....	4-27
Fig. 4.11. ^{13}C -NMR spectra of raw RH and the RH samples that sorb nickel from plating wastewater for 0.5, 12 and 24 h.....	4-32
Fig. 4.12. XANES spectra and their first derivative spectra of NiSO_4 reference and the RH samples that sorb nickel from plating wastewater for 0.5, 12 and 24h.....	4-33
Fig. 4.13. XANES spectra and their first derivative spectra of Ni(OH)_2 reference and the RHA samples that sorb nickel from plating wastewater for 0.5, 12 and 24h.....	4-34
Fig. 4.14. Fourier transforms of EXAFS spectra of the RH and RHA samples that sorb nickel from plating wastewater for 0.5, 12 and 24 h.....	4-35
Fig. 4.15 Residual weight of raw RH, Ni (NiSO_4)-containing RH and Ni (plating)-containing RH samples after heating at different temperatures for 2 h.....	4-42
Fig. 4.16. Ni leaching percentage of Ni (NiSO_4)-containing RH samples after heating at 105 - 1100 $^{\circ}\text{C}$	4-44
Fig. 4.17. XRD patterns of raw RH samples after heating at different temperatures.....	4-46
Fig. 4.18. XRD patterns of Ni (NiSO_4)-containing RH samples after heating at different temperatures.....	4-47
Fig. 4.19. XANES spectra and their first derivative spectra of NiSO_4 , Ni references and Ni (NiSO_4)-containing RH samples after heating at different temperatures.....	4-48

Fig. 4.20. Fourier transforms of EXAFS spectra of NiO reference and Ni (NiSO ₄)-containing RH samples after heating at different temperatures.....	4-49
Fig. 4.21. Ni leaching percentage of Ni (plating)-containing RH samples after heating at 105 - 1100 °C.....	4-55
Fig. 4.22. XRD patterns of Ni (plating)-containing RH samples after heating at different temperatures.....	4-56
Fig. 4.23. XANES and their first derivative spectra of NiSO ₄ , Ni references and Ni (plating)-containing RH samples after heating at different temperatures.....	4-57
Fig. 4.24. Fourier transforms of EXAFS spectra of NiO reference and Ni (plating)-containing RH samples after heating at different temperatures.....	4-58

Appendix A

Fig. A-1. Types of Adsorption isotherms.....	A-1
Fig. A-2. 電鍍製程及其廢水之產生流程.....	A-2
Fig. A-3. Elements of contained-sulfur drug detected by XRF.....	A-3
Fig. A-4. Elements of contained-sulfur drug detected by XRF.....	A-4
Fig. A-5. Elements of raw RH detected by XRF.....	A-5
Fig. A-6. Elements of raw RHA detected by XRF.....	A-6
Fig. A-7. Morphology (x 5000) of raw RH and the RH samples that sorb nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24 h.....	A-7
Fig. A-8. Morphology (x 5000) of raw RHA and and the RHA samples that sorb	

nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24h.....	A-8
Fig. A-9. FT-IR spectra of raw RH and the RH samples that sorb nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24h.....	A-9
Fig. A-10. FT-IR spectra of raw RHA and and the RHA samples that sorb nickel from 2000 mg/L Ni (II) solution for 0.5, 12 and 24h.....	A-10
Fig. A-11. Morphology (x5000) of raw RH and the RH samples that sorb nickel from plating wastewater for 0.5, 12, 24 h.....	A-11
Fig. A-12. Morphology (x5000) of raw RHA and the RHA samples that sorb nickel from plating wastewater for 0.5, 12, 24 h.....	A-12
Fig. A-13. FT-IR spectra of raw RH and the RH samples that sorb nickel from plating wastewater for 0.5, 12 and 24 h.....	A-13
Fig. A-14. FT-IR spectra of raw RHA and the RHA samples that sorb nickel from plating wastewater for 0.5, 12 and 24h.....	A-14
Fig. A-15. Morphology (x5000) of raw RH samples after heating at different temperatures.....	A-15
Fig. A-16. Morphology (x5000) of Ni (NiSO ₄)-containing RH samples after heating at different temperatures.....	A-16
Fig. A-17. FT-IR spectra of raw RH samples after heating at different temperatures.....	A-17
Fig. A-18. FT-IR spectra of raw RH and heated Ni (NiSO ₄)-containing RH samples at different temperatures.....	A-18
Fig. A-19. Morphology (x5000) of Ni (plating)-containing RH samples after heating at different temperatures.....	A-19
Fig. A-20. FT-IR spectra of raw RH and Ni (plating)-containing RH samples after heating at different temperatures.....	A-20
Fig. A-21.. XANES spectra and their first derivative spectra of raw Ni / SiO ₂ sample	

【Murthy, et al., 2004】.....	A-21
JCPDS 圖庫資料.....	A-22