別紙第１号様式　　　　　　　　　　　　No.1

博　士　論　文　の　要　旨

専攻名 Department of Science and Advanced Technology (システム創成科学専攻)

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博士論文題名

Metal Separation by Using Various Biomass Wastes

さまざまなバイオマス廃棄物を用いた金属分離

要旨（２，０００字程度にまとめること。）

Research of metal adsorption on biomass adsorbents has played the important role of metal recovery and radioactive metal removal, because of low cost and less pollution to environment. For the commercial technological recovery of precious metals from electronic waste, the preferable selectivity of adsorbents is certainly required, because the leaching solutions contain various metals. Biomass adsorbents produced from abundant resource not only possess various functional groups but also have high selectivity and capacity to various metal adsorption, which is comparable to other designed and synthesized organic adsorbents. Based on the advantaged priorities of biomass adsorbents, to find the simple and commercial method for recovery of precious and cesium removal on various biomass wastes were investigated in this research work. Depending on that objective purpose, the thesis consists of three parts.

The first chapter introduces the properties of precious metals and alkali metals, the supply and demand of precious metals, as well as advantages of biomass adsorbents for metal adsorption. From main component in biomass wastes, they are simply divided into three classes, polysaccharides-, polyphenols-, proteins-rich adsorbents. Hence, four representative substances, chitin powder, kiwi peels, tea leave and human hair were selected for investigation of metal adsorption and separately described at chapter 2, chapter 3 and chapter 4.

In second chapter, typical and natural polysaccharides adsorbents: chitin, cellulose and chitosan powder, were employed for gold, platinum and palladium adsorption. Two types of chitins from different resources had better performance on palladium and platinum adsorption than that of cellulose. Because of the solubility of chitosan into acidic solution, chitosan was not employed. The adsorption capacities of natural chitins for palladium and platinum were remarkable, capacities have potential to be improved by simple modification. To further study whether the modification of natural polysaccharides can improve the ability of precious metal adsorption, kiwi peel wastes with high content of cellulose were investigated for precious metal adsorption after crosslinking. The high adsorption ability and selectivity for Au(III) over Pd(II) or Pt(IV) were demonstrated by the simple modification. In addition, the result of XRD proved to the reduction of Au(III) during adsorption processes. It also led to long time to reach adsorption equilibrium.

The third chapter described cesium metal removal on the polyphenol adsorbents. Fresh and used tea leaves were used for cesium removal. Considered the real situation of polluted water and soil with cesium which contain large amount of sodium and some amount of potassium, adsorption of three kinds of alkali metals, sodium, potassium and cesium, was independently investigated. After modification with concentrated sulfuric acid, the crosslinked fresh and used tea leaves

showed high adsorption capacity of cesium, compared

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with reported other materials. The proton exchange mechanism of alkali adsorption on crosslinked tea leaves was elucidated and the adsorption reaction was also supported by coordination between oxygen atoms from ether groups and alkali metal ions to dehydrate water molecules of them. Therefore, both crosslinked tea leaves had preferable selectivity of cesium because of its low hydration energy. Moreover, cesium from the mixed solution with excess amount of sodium was removed by chromatographic column. The completely separation revealed the practical value of tea leaves for cesium removal in industrial application.

At fourth chapter, investigation of protein rich biomass adsorbents, human hair, for precious metal recovery was described. Without any modification, either the white or black hair exhibited higher adsorption ability for gold than those for platinum or palladium. Gold adsorption capacity of human hair is much higher than those of other reported biomass adsorbents. After adsorption, the shape of human hair was not changed by any damages and it was found that gold particles were aggregated on its surface rather than inner layer. Through the contacting of gold with various amino acids as a monomer of protein, it was observed that cystine was the main compound for gold adsorption on human hair as well as less effect of gold adsorption on amino acids with hydroxyl groups. The speculation of cystine appeared oxidation S-S bonds of protein in outmost and middle layers of human hair was confirmed by result of EDS analysis. The most of Pd(II) could be eluted from human hair within 5 minutes after competitive adsorption. Finally, the successful purification of three precious metals using human hair is proposed by three steps: adsorption of Au(III) and Pd(II) over Pt(IV) on human hair from mixed solution, elution of Pd(II) from gold loading human hair, incineration of gold loading human hair.

The fifth chapter summarized the results and discussion described in each chapter. Three types of biomass adsorbents had good performance on metal recovery and purification. Even some natural biomass adsorbents having weak adsorption performance, by simple modification, the adsorption of efficiency was improved. One of the most meaningful adsorbents are the protein rich adsorbents, human hair, without any modification. Purification of three precious metals, especially pure gold recovery was accomplished by combined processes as adsorption, elution and incineration with simple and effective routes.

As a result of research works concluded that biomass wastes have high potential for precious metals recovery and hazardous metal removal.