SS20 : 한국재료관련학회연합회 (FKMS) 2023 추계 연합포럼

SS20-1 | 한국재료관련학회연합회(FKMS) 2023년 추계 연합포럼

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한국세라믹학회, 대한금속・재료학회, 한국표면공학회, 한국열처리공학회, 한국복합재료학회, 한국부식방식학회, 한국주조공학회, 대한용접 · 접합학회, 한국소성가공학회, 한국분말재료학회, 한국자기학회, 한국재료학회, 한국자원리싸이클링학회 등 국내 13개 재료 관련 학회로 구성된 한국재료관련학회연합회는 회원 학회간의 학술정보 공유 및 학술활동 진작을 위한 상호 협력을 목적으로 2002년에 설립되어 운영되고 있습니다. 2023년 회장 학회인 한국세라믹학회 주관으로 한국세라믹학회 춘계학술대회(라마다프라자제주 & 제주오리엔탈호텔) 중에 4월 12일, 『12대 국가전략기술과 100대 미래소재』를 주제로 하는 『한국재료관련학회연합회 2023년 춘계 연합포럼』을 개최한 바 있습니다. 이어서 2023년 한국세라믹학회 추계학술대회(서울 COEX) 중에 10월 20일, 『한국재료관련학회연합회 2023년 추계 연합포럼』을 개최합니다. 『이차전지 전극소재 분석기술』을 테마로 각 학회에서 추천 받은 연사들 6분을 모시고 회장 학회인 한국세라믹학회, 부회장 학회인 대한금속・재료학회와 한국표면공학회, 감사 학회인 한국열처리공학회를 비롯한 13개 재료 관련 학회 회원간의 활발한 의견 교환의 장이 열립니다. 재료 분야 외부 환경 변화에 선제적으로 대응하기 위한 통찰이 도출되는 발전적 연합포럼이 될 것으로 기대합니다.

SS20-2 | Current status of material development and analytical issues in lithium batteries

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Globally, the growth trajectory of the battery industry is accelerating due to environmental and energy concerns, with South Korea prominently positioned as a leading nation contributing to this expansion. To develop next-generation high-performance batteries, in-depth understanding of the characteristics and structures of electrode materials is imperative. However, these materials present a challenging endeavor for precise analysis, given their nano-scale dimensions and intricate structures, beyond the capabilities of conventional analytical techniques. This study introduces the current state of battery material analysis technologies, with a particular focus on research and development of battery materials from the perspective of advanced analytical equipment such as TEM (Transmission Electron Microscopy), SEM (Scanning Electron Microscopy), FIB (Focused Ion Beam), and XRD (X-ray Diffraction). TEM and SEM enable high-resolution internal structure analysis of nano-scale materials, while FIB provides additional insights through depth profiling and cross-sectional preparation. XRD plays a pivotal role in addressing crystallographic aspects of materials. These analytical tools play a critical role in systematically exploring the characteristics of battery materials, facilitating optimized material development and enhancing battery performance. This research delves into the current status of battery material development and key analytical challenges, offering an in-depth discussion of specialized research methods and results obtained using TEM, SEM, FIB, XRD, and related analytical equipment.

SS20-3 | Current status and applications of neutron diffraction techniques for analyzing battery materials

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Neutron powder diffraction (NPD) techniques are extensively employed to study the crystal structure of a diverse range of materials, including ceramics, metals, polymers, and composite materials. This widespread application is attributed to the unique ability of neutrons to directly interact with the atomic nucleus, thereby providing comprehensive atomic details of light elements such as H, Li, Na, and O. Given that neutrons can penetrate thick specimens, they emerge as an ideal choice for bulk or powder sample measurements. Furthermore, neutrons facilitate quantitative discussions on adjacent elements in the periodic table, such as Mn, Fe, Co, and Ni, which poses challenges for X-rays. Taking advantage of the innate properties of neutrons, there has been a marked increase in research focusing on the structural characterization of electrode and solid-electrolyte materials for rechargeable batteries using NPD analysis. The electrochemical performance and structural stability of these materials are intimately connected to their crystal structure, encompassing factors like phase composition, microscopic stress, structural distortion, lattice defects, atomic occupation, and the dynamic behavior of mobile Li ions. NPD proves indispensable in unraveling these structure-property relationships. In this presentation, we will showcase the current state of neutron diffraction techniques and highlight their importance in battery material research. Special emphasis will be placed on the characterization of electrode and solid-electrolyte materials for Li rechargeable batteries. Several case studies will be introduced to illustrate how neutron-based characterization has advanced Li-ion battery research.

SS20-4 | Transmission Electron Microscopy on Battery Materials

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Lithium-ion batteries (LIBs) are recognized as the most important power supply for mobile electronic devices, with energy densities that have been increasing by 7-10% per year. There exists a persistent demand for advanced LIBs that exhibit reduced weight, longer life spans, and higher capacity. Transmission electron microscopy (TEM) has facilitated several breakthroughs in advancing our understanding of the degradation mechanism of electrode materials, particularly in the field of high-performance battery materials. Specifically, advanced TEM techniques have offered exceptional opportunities for monitoring the dynamic processes of electrode materials with high spatial and temporal resolution. In this talk, I would like to provide a comprehensive introduction to operando and cryogenic TEM analyses conducted on diverse battery materials, such as silicon, lithium metal, sulfide solid electrolytes, etc. The results of this study have the potential to advance the fundamental understanding of battery material dynamics. Additionally, by leveraging EDS and EELS, it is found correlations between interfacial layer properties and ionic conduction characteristics. The results can elucidate a particular issue pertaining to the chemical structure of SEI layers that can provide precise data and efficient improvement solutions for the advancement of secondary battery interface technology.

SS20-5 | Multi-scale/multi-modal characterization studies of battery materials using synchrotron based X-ray technique

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Lithium-ion batteries (LIBs) have revolutionized the field of portable electronics and are essential for advancing electric vehicles (EVs). However, further improvements in energy density, cycle life, and safety are still required to meet the growing demands of these applications. To achieve this, a comprehensive understanding of LIBs' scientific aspects, such as charge storage mechanisms, performance degradation, and electrode/electrolyte interfaces, is crucial. In this presentation, we will explore the capabilities of synchrotron-based X-ray techniques as powerful analytical tools for investigating LIBs. These techniques enable the study and monitoring of changes in the crystal structure, electronic properties, chemical composition, and morphology of electrode materials. Through a review of successful applications, we will demonstrate how these techniques provide valuable insights for enhancing the performance of existing systems and designing new battery materials. Emphasis will be placed on combining complementary length scales, chemical sensitivity, and probing depths, which provide a comprehensive understanding of the complex chemistry involved in LIB research.

SS20-6 | Chemcial state studies of soild state battery and their materials using Photoelectron spectroscopy techniques (XPS)

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Photoelectron spectroscopy techniques has recently gained significant recognition as a fundamental methodology in battery material research. Particularly in solid-state batteries, it plays a crucial role by integrating advanced analytical techniques such as in-operando analysis, thus facilitating a comprehensive understanding of battery materials, making it an indispensable technology for advancing battery technology. This study introduce the chemcial state changes in soild state battery and their materials using photoelectron spectroscopy techniques (XPS). (1) First, we introduce the short summary of the fundamental principles of XPS and showcase examples of XPS analysis in the field of solid-state batteries, providing a method to accurately understand the chemical characteristics of electrode materials. (2) This contribution will discuss that significant issues in the field of XPS analysis of battery materials, including the effects of exposure to oxygen, moisture, and X-ray irradiation and their solution. Analyzing the impact of these factors on the performance and stability of electrode materials offers valuable insights into the reliable measurement condition and their interpretation. (3) Finally, we will address that results from "In-operando XPS analysis," allowing real-time tracking of lithium (Li) migration and chemical changes within the electrode. This in-depth understanding of electrode operation principles and stability is expected to play a crucial role in advancing solid-state battery technology.