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方兴未艾的三元层状材料及其二维衍生物

黄 庆[1], 王京阳[2]

(1. 中国科学院 宁波材料技术与工程研究所, 先进能源材料工程实验室(筹), 宁波 315201; 2. 中国科学院 金属研究所, 沈阳材料科学国家研究中心, 沈阳 110016)

MAX 相材料是由三种元素组成的天然层状碳氮化物无机非金属类材料, 其具有金属的导电和导热性质, 也具备结构陶瓷的高强度、耐高温、耐腐蚀等苛刻环境服役能力。MAX 相材料在高温润滑、耐氧化涂层、事故容错核材料、自修复复合材料和能源材料等领域获得了广泛的关注, 国内外材料学家都在积极开展大量的探索研究。MXene 材料是通过“自上而下”的合成手段将 MAX 相材料中 A 位元素腐蚀抽离而形成的, 从 MXene 的命名可以看出其兼具 MAX 相的晶体结构单元和石墨烯(Graphene)的二维原子层的形貌特征。MXene 材料的合成引起了纳米领域的极大兴趣, 尤其是在储能研究方面不断地涌现出高水平的工作。我国在 MAX 相结构材料和 MXene 能源材料领域均取得了显著的成绩, 随着合成技术的发展和多学科交叉的深入探索, 目前已经有越来越多的国内材料研究小组投身此类新颖材料的研究。

中国科学院宁波材料技术与工程研究所每年四月一日的“新颖材料制备与应用研讨会”在 2019 年将“层状材料的结构化学与功能探索”作为主题, 重点讨论了在无机材料领域备受广泛关注的三元层状碳/氮化物材料(MAX 相)和其衍生的二元层状过渡金属碳/氮化物纳米材料(MXene), 以及其它无机纳米层状材料等。希望通过不同学科间的专业交流, 促进对于无机层状材料结构/化学的深入理解, 拓展对该类材料在先进能源、摩擦、储能、环境、催化、传感、生物、隐身等应用领域的研究。会议吸引了国内外七十余位专家学者, 包括 MXene 的首次报道者 Michael Naguib 博士等, 就 MAX 相和 MXene 材料领域的学术前沿和未来发展展开了热烈的讨论, 取得了很好的学术交流效果。

为了更好地总结这次会议的交流结果, 《无机材料学报》特别以“层状材料的结构化学与功能探索”为主题出版了本期专辑。专辑邀请中国科学院金属研究所王京阳研究员和中国科学院宁波材料技术与工程研究所黄庆研究员作为客座编辑, 并集中了我国在该领域较活跃的优秀学术带头人撰写论文。本专辑体现了 MAX 相和 MXene 材料在结构陶瓷、功能材料、纳米驱动、储能应用、新材料合成和理论模拟等多学科的最新成果, 集中讨论目前国内外广泛关注的科学问题。通过本期专辑的组织和出版, 我国的 MAX 相和 MXene 材料领域必将迎来新的历史发展阶段。

Layered Ternary Materials and Their Derivatives is Still Unfolding

HUANG Qing[1], WANG Jing-Yang[2]

(1. Engineering Laboratory of Advanced Energy Materials, Ningbo Institute of Materials Technology & Engineering, Chinese Academy of Sciences, Ningbo 315201, China; Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy Sciences, Shenyang 110016, China)

MAX phases are a family of natural occured layered carbides and nitrides which are composed of three different kinds of elements. As one kind of inorganic nonmetallic materials, MAX phases combine the properties of metals, *e.g.* good electrical and thermal conductivity, and ceramics, *e.g.* high strength, high-temperature stability, and corrosion resistance that are required for harsh environment service. At present, MAX phases have gained extensive attentions and been widely investigated for various of applications, including high-temperature lubrications, oxidation-resistant coating, accident tolerant fuels, self-healing composites, energy storage materials. MXene, ‘top-down’ synthesized through selective etching of the A-site elements from MAX phase, combines the MAX phase-like topology structure and graphene-like morphology. Up till now, MXene has received great interest in the fields of both

nano-science and technology. Especially, in the energy storage field, profound researches on MXene are rapid accumulating. In China, great achievement has been done in the study of MAX-phase structural materials and MXene energy storage materials. With development of synthesis technology and deepening of interdisciplinary studies, an increasing number of research groups are joining in this hot field.

Every year on April 1st, Ningbo Institute of Materials Technology& Engineering (Chinese Academy of Sciences) conducts a seminar on Synthesis and Applications of Novel Materials. In 2019, the Structural Chemistry and Functional Exploration of Layered Materials was selected as the theme of the seminar, focusing on MAX phases and their two-dimensional derivatives MXenes, and other kinds of nanolaminates. The aim of this seminar was to deepen the understanding of these layered materials and expand their applications for advanced energy, friction & wear, energy storage, environmental materials, catalysis, sensors, biology, stealth coating, through interdisciplinary communicating, and attracted more than 70 scholars to attend, including the inventor of MXenes, Dr. Michael Naguib. The research frontiers and future developments of MAX phases and MXenes were well discussed.

In order to integrate the ideas produced from attendees, *Journal of Inorganic Materials* publishes a special issue on "Structural Chemistry and Functional Exploration of Layered Materials" to represent collections of papers presented at this seminar. Prof. WANG Jing-Yang (Institute of Metal Research, Chinese Academy Sciences) and Prof. HUANG Qing (Ningbo Institute of Materials Technology & Engineering, Chinese Academy of Sciences) are invited as guest editors, and distinctive academic leaders active in this field are called for contributing papers. This special issue embodies the latest research achievements of MAX phases/MXenes in the fields of structural ceramics, functional materials, nano-driving, energy storage, material synthesis and theoretical simulation, which are the widely concerned scientific issues around the world. We believe that with the organization and publication of this special issue, a new historical stage of MAX phase and MXenes development is coming in China.

黄庆，研究员，博士生导师。现任中国科学院宁波材料技术与工程研究所先进能源材料工程实验室主任，《无机材料学报》副主编。中国科学院百人计划，中国核学会核材料分会常务理事、辐照效应分会理事，中核集团核燃料与材料研发中心第一届专家委员会委员，《Scripta Materialia》客座编辑。现主要从事核能材料的开发与应用，包括三元层状陶瓷的制备与核电环境下物性与结构的表征，事故容错型核燃料包壳材料用新型复合材料的设计与评估，陶瓷基复合材料的制备，二维无机材料及能源材料研究等。发表学术论文 200 余篇，获引 4200 余次，h 指数 34。申请专利 86 项(含 78 项发明专利)，其中 28 项已获授权，著作 1 部(章)。

E-mail: huangqing@nimte.ac.cn

王京阳，研究员，博士生导师。现任中国科学院金属研究所沈阳材料科学国家研究中心陶瓷及复合材料研究部主任，《无机材料学报》副主编。世界陶瓷科学院院士、美国陶瓷学会会士；国家“万人计划”科技创新领军人才、科技部“中青年科技创新领军人才”、中国科学院特聘研究员和沈阳市杰出人才等；担任世界陶瓷科学院论坛主席、美国陶瓷学会董事/工程陶瓷部主席、欧洲陶瓷学会国际顾问委员、中国物理学会内耗和力学谱分会副主任、中国硅酸盐学会特种陶瓷分会理事等学术组织职务；获得 Acta Materialia 银质奖章、美国陶瓷学会的全球大使奖/全球之星奖等、美国金属学会 ASM-IIM Visiting Lectureship 奖、国家科技进步二等奖、工信部科技进步一等奖、辽宁省自然科学一等奖等。主要从事极端环境用陶瓷及复合材料的创新设计与模拟、多尺度可控制备和近服役性能评价等工作。

E-mail: jywang@imr.ac.cn