

非晶态碳向纳米洋葱状富勒烯转变机理及其物性的研究

Investigation of transformation mechanisms and physical properties
of nanosized onion-like fullerenes from amorphous carbon

项目批准号：50025103

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本项目用高能束原位辐照和金属纳米微粒催化的方法，在原子水平级动态观察研究了非晶态碳（活性炭、煤炭等）向纳米洋葱状富勒烯类物质转变的机理、形成动力学、晶体结构、原子结构及其电子结构等。在此基础上，探索电子束照射、等离子体法或真空加热处理的方法下的宏量制备方法与工艺。对其产物进行结构和物性表征，探讨其应用前景，为该物质的生产与应用提供可靠的理论根据和实验数据。

● 主要研究成果与重要进展

- （1）发现了在电子束照射下、在Al、Au、Pt、Cu、Ni等金属纳米微粒催化共同作用下，非晶态碳向纳米洋葱状富勒烯转变的现象；
- （2）成功制备出单核、多核洋葱状富勒烯、金属纳米微粒内包洋葱状富勒烯、金属原子处于洋葱状富勒烯层间的夹层化合物（intercalation compounds）、金属/洋葱状富勒烯纳米薄膜、纳米碳绳等六种新型结构碳材料；
- （3）发现了用传统的弧光放电法可宏量制备洋葱状富勒烯工艺；
- （4）用等离子体法首次由非晶态碳制备出了具有新型结构的碳材料---碳纳米绳类物质。

本成果在Acta Materialia, Nanostructured Materials等杂志发表学术论文10余篇，申请、获准专利3项。



Fig.1 Experimental Procedure(INTEM)

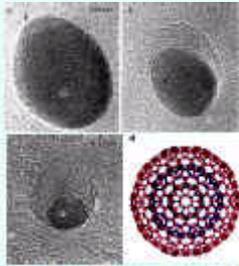


Fig.2 Fullerenes catalysed by Al nanoparticles

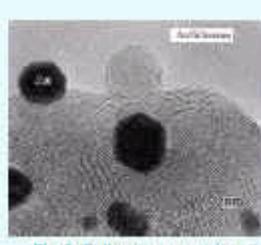


Fig.3 Fullerenes catalysed by Au nanoparticles

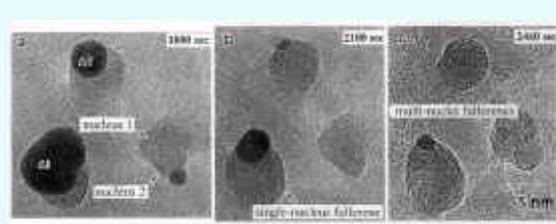


Fig.5 Two nuclei catalysed by one Al nanoparticle

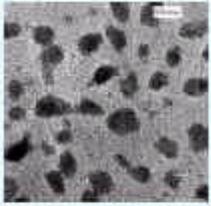


Fig.4 Fullerenes catalysed by Pt nanoparticles

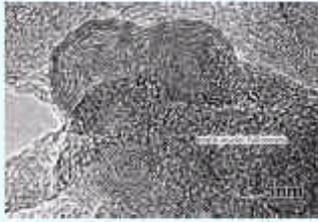


Fig.6 Two nuclei catalysed by different Al nanoparticles

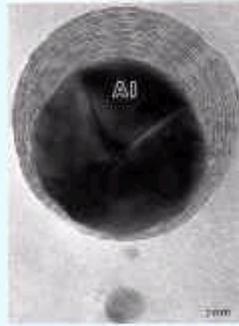


Fig.7 Al decahedral nanoparticle encapsulated by fullerenes

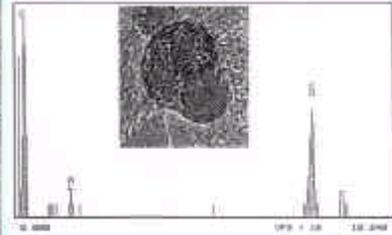


Fig.8 Al-atom intercalated fullerenes (analysed by EDS)

煤炭向富勒烯类物质转变的研究(Formation of fullerenes from coal)

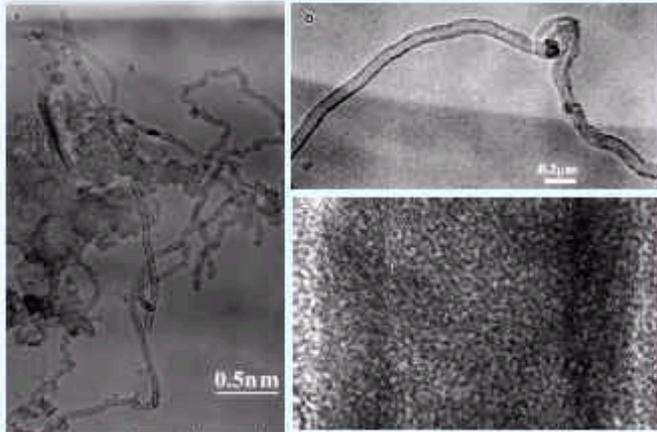


Fig.9 Images of nanotubes and nanostrings from coal by plasma method
a) Nanotubes and nanostrings; b) Catalyzed transformation from nanostrings (rectangled part) to nanotubes (circled part), c) An HRTEM image of nanotubes indicated by the circle in Figure 9(b)



Fig.10 HRTEM Images of nanosized onion-like fullerenes from coal by electron beam irradiation. a) intertwined structure from irregular nanosized onion-like fullerenes; b) intertwined structure from regular nanosized onion-like fullerenes