Role of transient surface hydrogen on Al catalyzed Si nanowire growth

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Bottom-up synthetic approach utilizing metal catalyst and vapor phase precursor molecules is widely employed to grow semiconductor nanowires. Al has received attention as growth catalyst since it is free from contamination issue of Si nanowire leading to the deterioration of electrical properties. However, unlike Au-Si system, has relatively narrow window for stable growth, showing highly tapered sidewall structure at high temperature condition. Although surface chemistry is generally known for its role on the crystal growth, it is still unclear how surface adsorbates such as hydrogen atoms and the nanowire sidewall morphology interrelate in VLS growth. Here, we use real-time in situ infrared spectroscopy to confirm the presence of surface hydrogen atoms chemisorbed on Si nanowire sidewalls grown from Al catalyst and demonstrate they are necessary to prevent unwanted tapering of nanowire. We analyze the surface coverage of hydrogen atoms quantitatively via comparison of Si-H vibration modes measured during growth with those obtained from postgrowth measurement. Our findings suggest that the surface adsorbed hydrogen plays a critical role in preventing nanowire sidewall tapering and provide new insights for the role of surface chemistry in VLS growth.