In situ transmission electron microscopy (TEM), which has proved to be a powerful method for visualizing the physical processes involved in the growth of nanowires by the vapour liquid solid (VLS) mechanism, was used to study VLS SiNW contact formation process. Electrical characteristics and effects of surface modification on electrical behavior of SiNW were also investigated in situ.

SiNWs were grown on silicon microcantilever heaters using the VLS mechanism. When grown across a gap between adjacent cantilevers, contact was formed when the SiNW impinged on the sidewall of an adjacent cantilever. Using in situ TEM, SiNW contact formation process at high temperatures was observed in real time. As the eutectic droplet made contact, it wetted the surface; Si growth catalyzed by the eutectic continued, while at the same time Au often migrated/diffused away from the contact site. The parameters of this contact formation process were measured from movies recorded during contact events. It is demonstrated that the geometry of the final contact formed between the nanowire and the silicon surface could be controlled by varying the contact surface temperature and the electrical current through the bridging SiNW. By adjusting the contact surface temperature and nanowire current, the balance of Si deposition vs. Au migration could be controlled. This gave rise to a variety of contact geometries including a Si to Si contact with controlled shape and diameter, a nano gap, or a Si-Au-Si contact. It is further demonstrated that electromigration is the best candidate for controlling catalyst migration. Kinetics of the contact formation process was studied in detail and the conditions which resulted in different contact geometries are explained.

On completion of the contact, SiNW bridging the adjacent cantilevers was electrically connected at its two ends, base and tip and its electrical properties were probed in situ TEM. Such SiNW bridges clamped between two cantilevers in situ TEM was an interesting platform for studying the effect of surface modification on SiNWs electrical properties. The effect of surface oxidation was studied and it is demonstrated that oxidation causes substantial increase in the resistance of the nanowire.

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