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Interdiffusion of Template-Synthesized Au/ Sn/Au Junction Nanowires and Nano-welding of Au-Sn Nanowires

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Elemental metals or alloys, which have long been used as interconnect materials in conventional electronic devices, should also be good candidate materials for interconnects in nanodevices of the future. In such interconnects, interfacial transport and reactions at nanojunctions will be very significant due to the increased surface area, and will strongly affect the quality and lifetime of the nanodevices [1]. Thus, it is of interest to investigate the interdiffusion between two components in one-dimensional nanostructures. The Au-Sn system is an interesting one to study because interdiffusion is expected to occur at relatively low temperature. Sn-based alloys are also among the most promising lead-free solders, and knowledge of the interfacial reactions between nanoscale Sn solders and electronic substrates is essential [2]. Here we report a study of the interdiffusion of striped Au/ Sn/Au nanowires and nano welding of Au-Sn nanowires.

Striped Au/Sn/Au nanowires were fabricated by electrodepositing metals (Au and Sn) into commercially available polycarbonate membranes (SPI Probe Inc.). The nanowires were harvested by dissolving the polycarbonate membrane in dichloromethane and were separated from the solvent by means of a centrifuge. The free standing nanowires were stored as a suspension in ethyl alcohol[1].

Figure 1 shows a STEM ADF image and EDX analyses of a representative Au/AuSn/$AuSn_4$/Sn/Au nanowire. Locally enlarged images of the top Au/Sn and bottom Sn/Au junctions are shown as insets. The letters A, B, C, D, and E along the wire axis represent positions at which EDX spectra were recorded. Cu signals originated from the Cu TEM grid. As expected, the presence of the AuSn and/or $AuSn_4$ intermetallic phase was confirmed for almost all nanowires. It is also noteworthy that when a nanowire possesses an uneven cross-section, the AuSn compound section is thicker than Au or Sn section due to the Kirkendall effect.

Figure 2(a) is an Au nanowire overlapped with a Sn nanowire, after the electron beam was focused on the overlapped nanowires; the Au and Sn wires started welding together. Shown in Figure 2(b) is the final image after 600 s electron bean nano welding, it is clearly observed that the AuSn intermetallic compound was formed during the electron beam welding process.

References

[1] M. Tian, J.Wang, J. Snyder, J. Kurtz, Y. Liu, P. Schiffer, T. E. Mallouk and M. H. W. Chan, Appl. Phys. Lett., 83 (2003) 1620.
[2] J. Glazer, Int. Mater. Rev., 40 (1995) 65.
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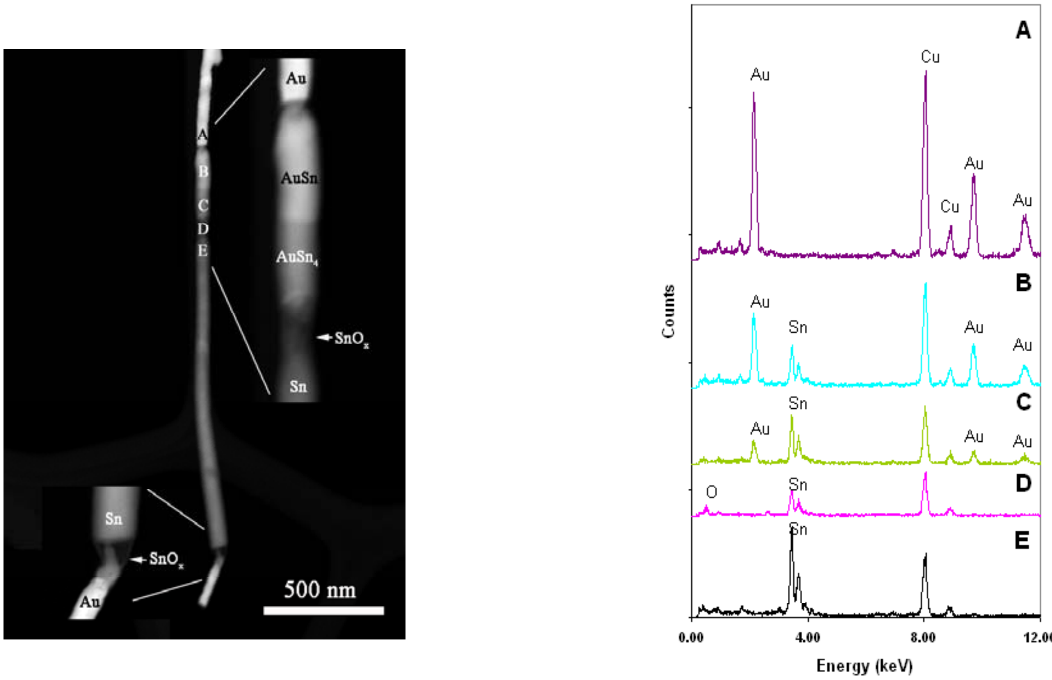

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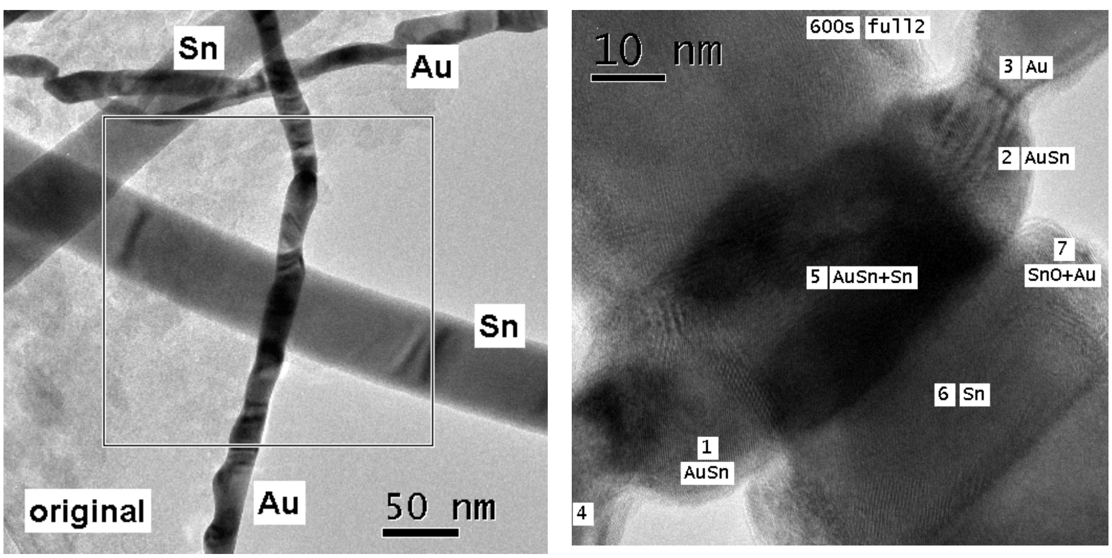

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