Catalyst Selection for ZnO Nanowire Growth

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ZnO nanowires (NWs) are commonly grown by the vapor-liquid-solid (VLS) method utilizing nanometer-sized catalytic metal islands as nucleation sites. Metal catalysts are often selected arbitrarily with no correlation to the resulting ZnO NW properties. We reports a systematic assessment of how Group IB metals and alloys influence growth and structural/electronic properties of ZnO NWs.

An experimental library was designed using Au-Ag-Cu phase diagram and included 5 metal compositions: Au, Ag, AuCu, AgCu and AgAuCu. The metal library elements were deposited on GaN/sapphire substrate followed by annealing (to study metal dewetting behavior) and by ZnO growth. The resulting set of metal islands and ZnO NWs was characterized structurally and spectroscopically. It was found that the ZnO NW growth was significantly influenced by the nature of the catalytic metal and its dewetting behavior on GaN/sapphire substrate. For example, growth from Au islands at 850C (below the melting point of pure Au) yielded only a ZnO wetting layer with no NWs, while metal compositions that should melt at lower temperatures than Au produced a variety of NW shapes, sizes and orientations at this temperature. PL and CL spectra were also quite different for the ZnO NWs grown from different catalytic library elements: NWs fabricated from Ag islands at 850C produced the sharpest excitonic peak near 3.36 eV while the spectra were significantly broader for NWs grown from Au- and Cu-containing islands.

Similar approach can be applied for choosing metal catalysts for VLS growth of other compound semiconductors.