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The nucleation of ZnO nanowires on sputter deposited metal substrates

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ZnO is a II-VI semiconductor with a wide bandgap of 3.37 eV. This makes it a good candidate for transparent solar cells and for near-ultraviolet LEDs. In the following, a Ta/Ru/Au thin film is sputter deposited on a (110) Si substrate as a seed layer. The Ta layer appears to be amorphous while the orientation of the deposited metal films is found to be Ru (001), Au (111) by X-ray diffraction. This allows for epitaxial c-axis ZnO nanowire (NW) growth by metalorganic chemical vapour deposition at temperatures from 400˚ - 600˚ C. Such growth may be independent of substrate choice, as the orientation of the metallic seed layers will depend only on the characteristics of the amorphous Ta layer. Transmission electron microscopy (TEM) and XRD are used to demonstrate c-axis growth of ZnO on the deposited metal film. Scanning electron microscopy shows densely packed NWs. The height and separation increase with growth temperature while the misalignment increases with growth temperature. This is corroborated by rocking curve measurements which show increasing FWHM with growth temperature.

Additionally, possible growth by vapour-liquid-solid (VLS) method is explored. Atomic force microscopy (AFM) shows the successful formation of liquid Au droplets on the substrate surface following exposure to Triethyl Gallium (TEGa) at temperature above the Au-Ga eutectic point. By adjusting length or flow rate of exposure the size, number, and height of nanoparticles can be controlled. Atomic force microscopy (AFM) shows that longer exposure (or higher flow) leads to fewer, larger particles of greater height on the substrate surface. Under VLS growth, this would allow tuneability of NW dimension and dispersion on the substrate surface. However, TEM and energy dispersive spectroscopy (EDS) indicate that higher temperature growths may be necessary to achieve NW growth by VLS.

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