Abstract:
Catalyst features were patterned onto quartz substrates, from which well-aligned carbon nanotubes could be grown. Scanning electron microscopy was used to characterize the growths. Subsequent experiments with the carbon nanotube samples included array devices integrated into fluidic cells and on-chip Raleigh imaging and spectroscopy.

Summary of Research:
Carbon nanotubes (CNTs) have garnered much attention over the last two decades for their interesting and sometimes novel properties, which hold promise for a number of diverse applications [1]. An exciting recent synthetic development has been the capability to grow long, highly-aligned CNTs [2,3]. We have been using CNF resources to help prepare samples for aligned CNT growth and for characterization afterward.

Photolithographically-defined mapping marks are first etched into a quartz wafer, which is then diced into small chips. After an overnight anneal, lines of iron catalyst, 10 µm wide and spaced 150 µm apart, are patterned onto the chips. Using a chemical vapour deposition (CVD) furnace in our lab, we can grow well aligned CNTs, which serve as samples for further experimentation. Representative scanning electron microscope (SEM) images are provided in Figure 1.

These carbon nanotubes grown on quartz have served as initial samples for a variety of subsequent experiments. For example, electrodes have been deposited onto the quartz chips to form nanotube array devices from which fluidic cells were constructed. The cells combine bulk electrical characterization that includes electrolyte gating capabilities with an optical window, which could facilitate simultaneous spectral and electrical information to be gathered as chemicals are introduced to the cell in real time.

In another project, the as-grown samples served as a platform for on-chip Raleigh imaging and spectroscopy of carbon nanotubes. A representative optical micrograph of elastically scattered light from individual single-walled carbon nanotubes under widefield laser illumination is provided in Figure 2.

References:
Figure 1: SEM images of well-aligned CNTs grown on a quartz substrate; (a) wide view, (b) close up of catalyst line.

Figure 2: Representative spatial Rayleigh image showing more than 20 SWNTs simultaneously. Scale bar = 20 µm. [Courtesy of Daniel Joh, also in the Park Group].