Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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“Parametric Studies of Field-Directed Nanowire Chaining for Transparent Electrodes”

Department of Mechanical Engineering

EOW 230
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Engineering Office Wing
Room 230

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Dr. Helen Kurki, Department of Anthropology, UVic

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Abstract

Transparent electrodes (TE) have become important components of displays, touch screens, and solar photovoltaic (PV) energy conversion devices. As electrodes, the devices must be conductive while being transparent. Transparent materials are normally poor conductors and materials with high electrical conductivity, such as metals, are typically not transparent. From the few candidate materials, indium tin oxide (ITO) is currently the best available, but indium is an expensive material and ITO cost has risen with increasing demand. Therefore, alternative materials or methods are sought to encourage production needs of applications and help in reducing their price.

Here, this thesis presents and discusses results of work for a method to produce a TE device which is nanowire-based, with a figure of merit $\text{FoM} = 0.239 \times 10^{-3} \Omega^{-1}$, comparable to ITO, but with potential for far lower cost.

Using electric field-directed assembly, multiple parallel long chains of metal nanowires, are assembled on inexpensive transparent materials such as glass by field directed nanowire chaining, using methods first demonstrated in our laboratory. In this work, we have improved the fraction of functional chains, by tuning the field/voltage, a key step in increasing the FoM and lowering cost. The effect of operating parameters on TE optical and electrical properties has been studied and identified as well. From experiments with twenty seven substrates, each with a range of electric field and nanowire concentration, the highest light transmission achieved is 78% and the lowest sheet resistance achieved is $100 \Omega/\text{sq}$. Among all the operating parameters, the electric field has the most significant influence on the chaining process. A high electric field used for nanowire assembly increases the fraction of functional chains on the substrate, which enhances its optical and electrical properties.