Summary of Doctoral Thesis

Title of Doctoral Thesis: New morphological nanomaterials created by aqueous solution processes. 水溶液法による新形状ナノ物質の創成

Name: Rieken William Dee

Summary of Doctoral Thesis:

In the thesis, the author described novel electrical and optical properties of two nanomaterials smaller than 20 nm; the size and morphologies of the nanomaterials are controlled by carefully treating an aqueous solution process using the corresponding starting materials sources. Further, a controlled decomposition of the raw products allows fabricating the 20-nm nanomaterials.

The author found that five different nano-MgO samples have unique multiple optical bandgaps depending on the processing. The multiple bandgaps, confirmed by photoluminescent (PL) and UV-visible-near infrared (NIR) spectroscopy. The PL bands covering violet, (long-lived) green, red, and NIR regions were observed. The origin of the long-lived green emission is discussed.

Developing $YBa_2Cu_3O_{7-\delta}$, well-known as a high-temperature superconductor (HTSC) shown in the thesis, overcomes several common drawbacks; low yields, size distribution, long heating time, and unavoidable impurities. The process precision controls morphology (rods, tubes, wafers, bi-wafers, spiral shapes, and their hybrids) of $YBa_2Cu_3O_{7-\delta}$. The author discussed the electrical properties of nano-size $YBa_2Cu_3O_{7-\delta}$, associated with morphonology and compositions. Particularly, the nano– $YBa_2Cu_3O_{7-\delta}$ nanotube facilitates to fabricate flexible wires without post-heat treatment for the first time. Continued heating allows alterations in different morphology from a wafer to a spiral shape. The finding is promising a new class of HTSCs. The introduction of magnetism in $YBa_2Cu_3O_{7-\delta}$ that obeys the Curie-Weiss law may act as ferromagnetic pinning in the HTSCs.

In summary, this thesis presents a novel approach to fabricating two nanomaterials (MgO and $YBa_2Cu_3O_{7-\delta}$) using the aqueous solution process to produce the controlled nm-particles and various morphology. The new aqueous solution approach is very promising to reduce the environmental load in the future.

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Summary of Thesis Examination Results:

This thesis presents a novel approach to fabricating two nanomaterials (MgO and $YBa_2Cu_3O_{7-\delta}$) using a newly developed aqueous solution process to produce the controlled nm-particles and various morphology. The author described novel electrical and optical properties of two nanomaterials smaller than 20 nm; the size and morphologies of the nanomaterials are controlled by carefully treating an aqueous solution process using the corresponding starting materials sources. The author found that five different nano-MgO samples have unique multiple optical bandgaps depending on the processing. The PL bands covering violet, (long-lived) green, red, and NIR regions were observed. The origin of the long-lived green emission is discussed. Developing $YBa_2Cu_3O_{7-\delta}$, well-known as a high-temperature superconductor (HTSC) shown in the thesis, overcomes several common drawbacks; low yields, size distribution, long heating time, and unavoidable impurities. The process precision controls morphology (rods, tubes, wafers, bi-wafers, spiral shapes, and their hybrids) of $YBa_2Cu_3O_{7-\delta}$. The author discussed the electrical properties of nano-size $YBa_2Cu_3O_{7-\delta}$, associated with morphonology and compositions. Particularly, the nano– $YBa_2Cu_3O_{7-\delta}$ nanotube facilitates to fabricate flexible wires without post-heat treatment for the first time. Continued heating allows alterations in different morphology from a wafer to a spiral shape. The finding is promising a new class of HTSCs. The introduction of magnetism in $YBa_2Cu_3O_{7-\delta}$ that obeys the Curie-Weiss law may act as ferromagnetic pinning in the HTSCs. The new aqueous solution approach is very promising to reduce the environmental load in the future.

As described above this thesis has revealed new morphological nanomaterials created by aqueous solution processes. Because this knowledge is fundamentally important to the basic science of nanomaterial creation, the committee agreed that this thesis is worth as a PhD thesis for a Doctor of Science.