Electronic Supplementary Information

Enhanced microwave absorption of ZnO coated with Ni nanoparticles produced by atomic layer deposition

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**Fig. S1** XRD pattern of ZnO@NiO composites.

**Fig. S2** HRTEM image of ZnO@NiO.
**Fig. S3** (a) SEM of the ZnO@NiO and corresponding elemental mapping images of (b) Zn, (c) Ni and (d) O. Scale bar: 600 nm.

**Fig. S4** SAED pattern of an individual ZnO@Ni nanorod.
Conventionally the relaxation process which can be described by the Cole-Cole semicircle has an important influence on permittivity behaviors of microwave absorption materials. According to the Debye dipolar relaxation, the relative complex permittivity ($\varepsilon_r$) can be expressed by the following equation,

$$
\varepsilon_r = \varepsilon' + i\varepsilon'' = \varepsilon_\infty + \frac{\varepsilon_s - \varepsilon_\infty}{1 + i\omega\tau_0}
$$

(1)

where $\tau_0$, $\varepsilon_s$, and $\varepsilon_\infty$ are the relaxation time, the static dielectric constant, and the dielectric constant at infinite frequency, respectively. From eq 1, it can be deduced that

$$
\varepsilon' = \varepsilon_\infty + \frac{\varepsilon_s - \varepsilon_\infty}{1 + (\omega\tau_0)^2}
$$

(2)

$$
\varepsilon'' = \frac{\omega\tau_0(\varepsilon_s - \varepsilon_\infty)}{1 + (\omega\tau_0)^2}
$$

(3)

According to eqs 2 and 3, the relationship between $\varepsilon'$ and $\varepsilon''$ can be further deduced,

$$
(\varepsilon' - \frac{\varepsilon_s + \varepsilon_\infty}{2})^2 + (\varepsilon'')^2 = (\frac{\varepsilon_s - \varepsilon_\infty}{2})^2
$$

(4)

Thus the plot of $\varepsilon'$ versus $\varepsilon''$ would be a single semicircle, which is usually defined as the Cole-Cole semicircle, and each semicircle corresponds to one Debye relaxation process. Plots of $\varepsilon''$ versus $\varepsilon'$ for ZnO and ZnO@Ni composites are shown in Fig. S5, where four superimposed Cole-Cole semicircles are found for the ZnO@Ni sample.

Reference
Fig. S6 EDS of ZnO@Ni.

<table>
<thead>
<tr>
<th>Element</th>
<th>Mass percent</th>
<th>Atom percent</th>
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<tr>
<td>O</td>
<td>17.41</td>
<td>46.09</td>
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<tr>
<td>Zn</td>
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<td>50.01</td>
</tr>
<tr>
<td>Ni</td>
<td>5.4</td>
<td>3.9</td>
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