REVIEW

DISSERTATION THESIS TITLE: Creating and Studying New Composite Materials for Microwave Absorption in the Range of 8.8-12 GHz

Scientific supervisor doctor of Physical Chemistry, Professor Yomen Atassi. For the dissertation work of Anas Houbi, "Creating and Studying New Composite Materials for Microwave Absorption in the Range of 8.8-12 GHz", submitted for the degree of Doctor of Philosophy (Ph.D.) in the specialty 8D07104 - "Chemical technology of inorganic substances".

The mentioned Ph.D. candidate has studied the synthesis of new microwave absorption materials by different methods. In a first stage of this research, different parameters that affect microwave absorption performance of those materials were studied, as follows: the effect of ferrite type, substitution of the ferrite with several metal ions, the concentration of metal ions, absorbent layer thickness, and loading percentage of ferrite in paraffin matrix. In the second stage of this research, the effects of molar ratios of metal ions to citrate acid (1:1, 2:1, and 3:1), and aqueous solutions of PVA (1%, 4%, and 6%) on the RL_{min}, f_m, and SE_{max} were investigated. The results indicate that the aforementioned absorbers have a limited absorption bandwidth $BW_{-10\ dB}$ and a high loading percentage.

To cope with those limitations, a new strategy of preparation was adopted to decrease the loading percentage and increase the absorption bandwidth $BW_{-10\ dB}$ of the absorbers so that it covers most of the frequency band of 8.8–12.0 GHz. This was achieved by incorporating both magnetic loss materials (such as ferrites and carbonyl iron (CI)) and dielectric loss materials (such as carbon black (CB)).

In this respect, several parameters that affect microwave absorption performance of the absorbers were studied: ferrite nanocomposite type, the weight ratio of CB/$Ni_{0.5}Zn_{0.5}Fe_2O_4$, CB/$Mn_{0.1}Ni_{0.5}Zn_{0.4}Fe_2O_4$, CB/$Ni^{3+}_{0.25}Ni^{2+}_{0.375}Zn^{2+}_{0.25}Fe_2O_4$ and $Ni_{0.5}Zn_{0.5}Fe_2O_4$/CI/CB, and loading percentage. The results revealed the synergistic effects of incorporating ($Ni_{0.5}Zn_{0.5}Fe_2O_4$, CI) as magnetic loss materials and CB as a dielectric loss material on the microwave performance of the absorber. surface density SD, RL_{min}, SE_{max}, and $BW_{-10\ dB}$ of the prepared absorber. The best result obtained was by using F/CI/CB-111 composite. A RL_{min} indicated -19.4 dB at 9.9 GHz and $BW_{-10\ dB}$ was 3.2 GHz for a thickness of 6 mm.

To further enhance the RL value and obtain 99.9% absorption (attenuation), another dielectric loss material, based on inherently conducting polymers, was incorporated in the microwave absorber. According to that, several hybrid nanocomposites were

prepared using polyaniline (PANI) and spinel and/or hexagonal nanoferrites. The effect loading percentage, and weight ratios of PANI/Ferrite nanocomposite on electromagnetic interference (EMI) and microwave absorption performance were evaluated. Several parameters that affect microwave absorption properties were studied: PANI-based nanocomposites type, weight ratios of PANI/$Ni^{3+}_{0.25}Ni^{2+}_{0.375}Zn^{2+}_{0.25}Fe_2O_4$, and PANI/$BaNiZnFe_{16}O_{27}$, and the incorporation of CB and CI into hybrid nanocomposites. The results indicate that both RL and SE are improved by obtaining 99.9% absorption of the microwaves and decreasing the loading percentage from 45% to 25%, which means obtaining lightweight absorbers with outstanding characteristics.

Mr. Houbi Anas passed the internship at the Center on Complex Processing of Mineral Raw Materials. He gained excellent experience in synthesizing PANI-based nanocomposites which have unique microwave properties.

He published several articles in international peer reviewed journals which can be mentioned as an evidence of the high quality of the performed research. One of the published article was in the journal of Magnetism and Magnetic Materials indexed in the Scopus database with (111 citations till the date of the current report), two in the web of science database and four abstracts in international scientific conferences.

According to the novelty of the results obtained by Mr. Houbi, the quality of performed research, and its practical significance, the dissertation work of Mr. Houbi Anas, "Creating and Studying New Composite Materials for Microwave Absorption in the Range of 8.8-12 GHz ", submitted for the Ph.D. degree, constitutes a promising work for the development of novel composite materials for microwave absorption.

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