The Passive Generation of Low Frequency Noise Field by MRET-Shield Polymer Compound and Following Amplitude Modulation of RF Carrier Signals

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Abstract This article is related to the experimental data regarding the ability of polar polymer compound (MRET-Shield polymer) exposed to the external electromagnetic fields of RF range of frequency to generate low frequency composite noise fields. Due to the fractal geometry structure of MRET-Shield polymer compound and the phenomenon of piezoelectricity, this polymer generates subtle, low frequency, non-coherent electromagnetic oscillations (composite noise field) that can modify RF signals as a result of superposition phenomenon. The superposition of composite noise field generated by MRET-Shield polymer compound and RF microwave signals leads to amplitude modulation of RF signals where random low frequency signal generated by MRET-Shield compound is a modulating signal and original microwave signal is a modulated one. To verify the visibility of the proposed hypothesis MRET-Shield polymer compound was tested at MET laboratories, Inc., USA. This test also confirms that the introduction of MRET-Shield polymer to the source of RF signals in the range of 800 MHZ, 900 MHz, 1800 MHz, 1900 MHz, and 2400 MHz does not significantly affect the air measurements of RF signals, and subsequently does not lead to any significant distortion of transmitted RF signals.

Keywords Noise Field, Fractal, Polymer, Amplitude Modulation

1. Introduction

While many polar polymers are highly flexible and form an amorphous solid upon the process of polymerization, a large number of polymers, such as epoxy, actually form partially crystalline structures. A number of studies show that the external electromagnetic field can affect local orientations and phase transitions in polymer crystalline systems of longitudinal chains. The longitudinal polymer crystalline system is a macromolecule of consecutively co-polymerized liquid crystals and flexible polymer sequences. Polar polymers possess comparatively low values of relative dielectric permittivity (3-15), which means that macromolecules in the molecular structure of these polymers can be easily displaced by external electromagnetic force. Subsequently the external electromagnetic field can seriously modify the local orientation order of the system and affect phase transition parameters and dielectric properties of the polymer compound. A simple molecular mechanism exists since the polar parts of the molecule in epoxy are rigidly attached to the chain backbone. The orientation of the polar groups in the electromagnetic field affects the backbone orientation and determines the resulting anisotropy of crystalline structure of epoxy polymer introduced to the electromagnetic field. The existence of orientations and phase transitions in crystalline systems of epoxy polymer introduced to external electromagnetic field leads to the origination of subsequent relaxation and strain phases in macromolecular structures that induce the phenomenon of piezoelectricity. Piezoelectricity is the electrical response of a material to the change of pressure in molecular structures of polymer compound. It can only be observed in materials having a non centre-symmetrical structure and elastic properties. Both properties can be found in polar polymer compounds. The piezoelectric effect of polymer compounds directly depends on the order state of the liquid crystalline phase structures. It means there is direct correlation between the topology of polymer molecular structures and the intensity of piezoelectric phenomenon. The topology of polymer molecular structure is scientifically based on the principles of formation of fractal systems (Smirnov, 2008).

The epoxy polar polymer material is a good example that presents all qualities of volumetric fractal matrix. The epoxy polymer samples were studied with the help of small-angle X-ray scattering (SAXS). The analysis of the entire scattering curve of an epoxy compound suggests a fractal behaviour of the internal surface on a scale between 100 nm and 10 nm. The first principle of fractalization is realized through the iterative algorithm of formation of complex structural sys-

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tems based on the existence of the initial prototype matrix which governs the formation of the object. In this case, the final system's iterative formation consists of the successive reflection of the initial prototype matrix on the final structure of the whole system. As a result, the final multilevel fractal structure has long distance correlations in the arrangement of particles. Any small fragment of the fractal system reproduces the structure of the whole system under the increasing scale. Another principle that governs formation of the fractal system is the principle of complementarity. The main criterion of the integrity of fractal system is minimization of tendencies leading to spontaneous formation of "inside" conflicts and contradictions in the system. It states that in order to achieve stability of any complex system the level of inside "contradictions" of this system should be directed to null. The basis of formation of stable complex system should be the structural module which has precise, balanced matrix structure and can clone self projections in the surrounded environment. The fractal cloning of structures considers the formation of self-similar replications of the initial basic module with the specific coefficient of similarity. The object which is formed as a result of the fractal cloning process has dimensions that are proportional to the dimensions of the initial basic module. The next basic principle that governs the formation of the fractal system in nature provides the idea of existence of the lattice of "barrier" membranes. Any fractal system is separated by barrier membranes relative to the central zone of the system, and those membranes play roles of transformers and converters of the previously existing algorithm or signal into another algorithm or signal which is more adequate for the present level. In this case, the transmission of the signal from the central zone of the fractal system to the peripheral zone of the same system and vice a verse is related with its step by step adaptation. This principle can be interpreted as a process of quantum transformations of the entropy of the object. In this case each barrier membrane of the system is considerate to be some kind of a fractal "space – wave" filter which modifies the previously existing algorithm or signal into the new form of algorithm or signal. This concept provides some evidence that the encounter of fractal matrix with the electromagnetic field has

the ability to affect this field in a way obviously characterized by the matrix's structure (Smirnov, 2008). The introduction of foreign agents (substances) into the parent lattice of epoxy polymer leads to the effect of superimposed periodicity and, as a result, develops modulated crystalline structures with specific fractal microstructure, phase transition, network topology and polarity. It is a basic concept of MRET-Shield epoxy based polymer compound patented in the USA. Due to the fractal geometry structure of MRET-Shield polymer compound and the phenomenon of piezoelectricity, this polymer generates subtle, low frequency, non-coherent electromagnetic oscillations (composite noise field) that can modify RF signals as a result of superposition phenomenon. To verify the visibility of the proposed hypothesis MRET-Shield polymer compound was tested at MET laboratories, Inc., USA. This test also confirms that the introduction of MRET-Shield polymer to the source of RF signals in the range of 800 MHZ, 900 MHz, 1800 MHz, 1900 MHz, and 2400 MHz does not significantly affect the air measurements of RF signals, and subsequently does not lead to any significant distortion of transmitted RF signals.

2. Method and Materials

MRET-Shield polymer compound was tested at FCC certified MET Laboratories, Inc. in Santa Clara, California, under supervision of project engineer Charles Huang; MET Report: EMCS31777.

Test configuration and setup:

MET Laboratories Inc. used for the testing of MRET-Shield polymer compound the following equipment configuration:

Testing was set up in a semi-anechoic chamber, and with calibrated immunity equipment as dictated by EN61000-4-3. Test was performed to measure MRET-Shield ability to modify radiated immunity levels of the following frequencies: 800 MHz, 900 MHz, 1800 MHz, 1900 MHz, and 2400 MHz.
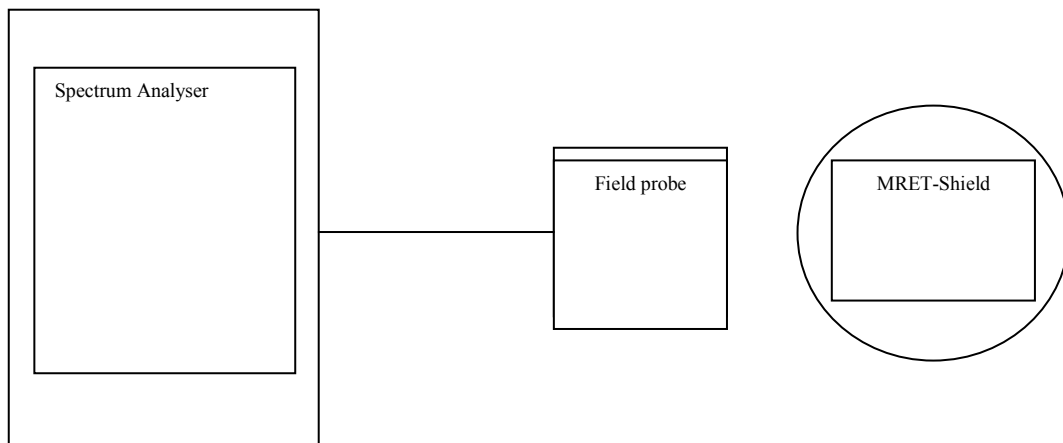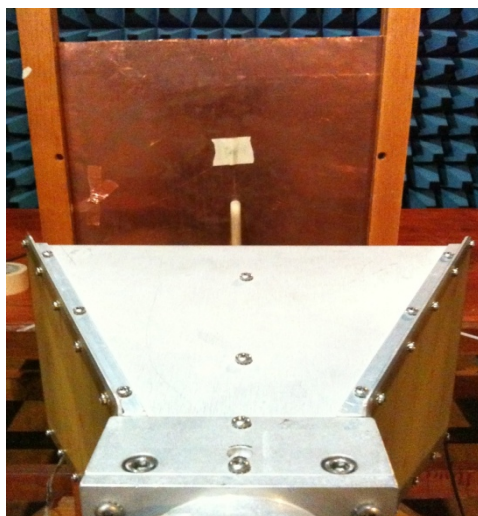

Figure 1. Block diagram of test configuration

Picture 1. Horn Antenna and testing platform

Picture 2. Isotropic Electric Field Probe

Picture 3. Testing platform with MRET-Shield

Picture 4. Testing platform without MRET-Shield

Table 1.

Test Name: MRET-Shield Low Frequency Noise Field Test			
Met Asset #	Nomenclature	Manufacturer	Model
1s2264	3 Meter Chamber	Lindgren	N/A
1s2401	Bilog Antenna	Schaffner	Cbl6140a
1s2208	Horn Antenna	Emco	3115
1s2643	Signal Generator 40ghz	Anritsu	Mg3694b
1s2576	Amplifier (80-1000mhz)	Amplifier Research	500w1000a
1s2478	TWT Amplifier	Communications & Power Industries	Vzl6943j2
1s2460	1-26ghz Spectrum Analyser	Agilent Technologies	E4407b
1s2408	Set, Probe, Near Field	ETS	7405
1s2579	Isotropic Electric Field Probe	ETS-Lindgren	Hi-6053

Table 2.

| Freq (MHz)	Input drive (dBm)	Scan without MRET-Shield (dBm)				Scan with MRET-Shield (dBm)				Δ(dB)
		Scan 1	Scan 2	Scan 3	Avg	Scan 1	Scan 2	Scan 3	Avg	
800	-32	-30.7	-30.81	-30.84	−30.78	-30.18	-30.53	-30.64	−30.45	-0.33
900	-36	-28.44	-28.82	-28.91	-28.72	-29.57	-29.59	-29.64	-29.60	0.88
1800	-42	-47.99	-48.1	-48.23	-48.11	-48.24	-48.3	-48.33	-48.29	0.18
1900	-47	-49.78	-50.06	-50.39	-50.08	-50.55	-50.56	-50.53	-50.55	0.47
2400	-37	-56.88	-56.96	-57.03	-56.96	-57.27	-57.44	-57.47	-57.39	0.44

3. Results

Test results

The standard level of Uncertainty for the measurement of electric field strength for Spectrum Analyser Agilent E4407B is ±0.5 dB. The mean value of electric field strength in this case is calculated using 3 measurements/scans, which means that its level of Uncertainty is $|0.5| / \sqrt{3} = 0.29$
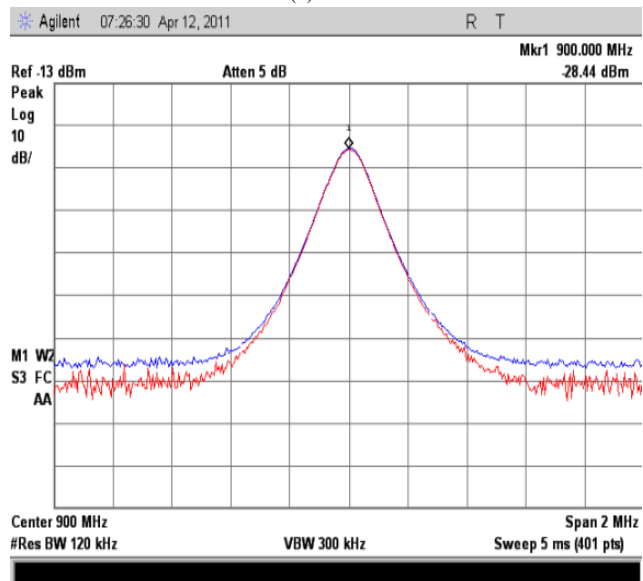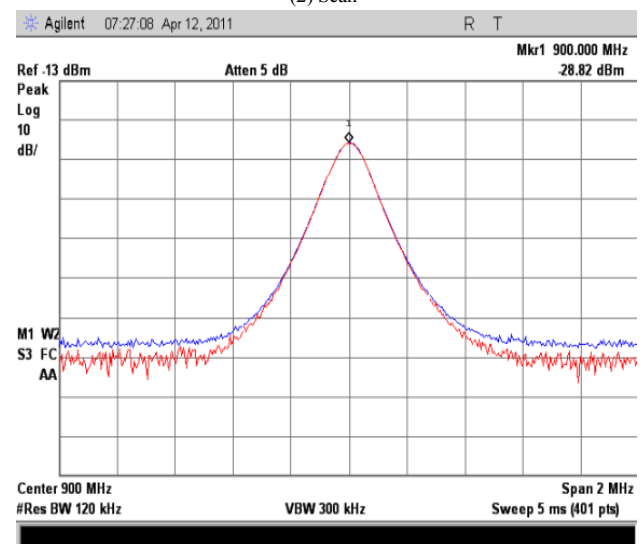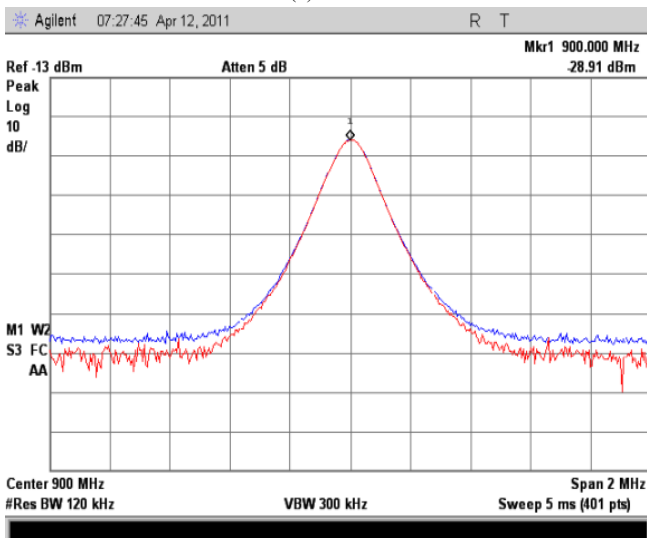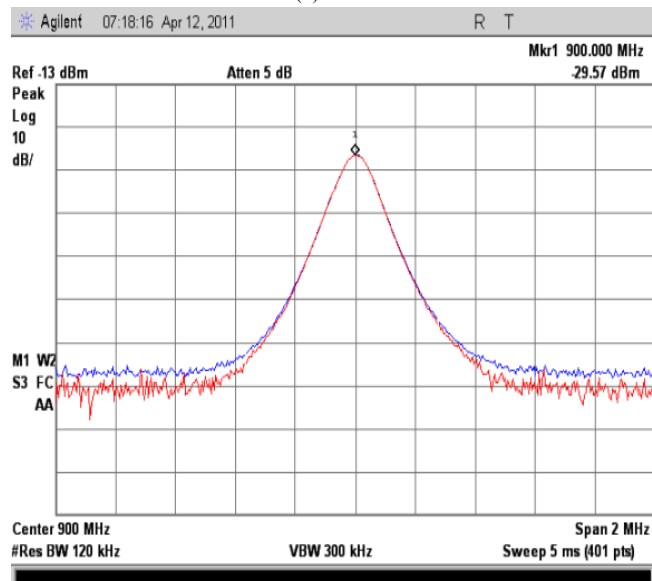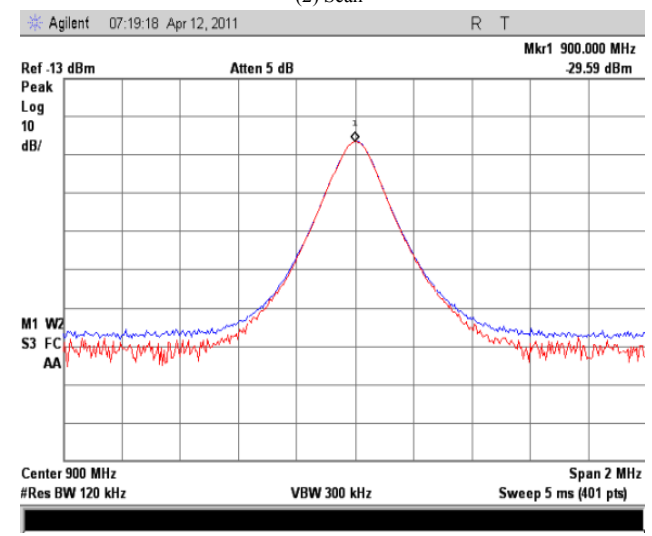
800 MHz without MRET-Shield:
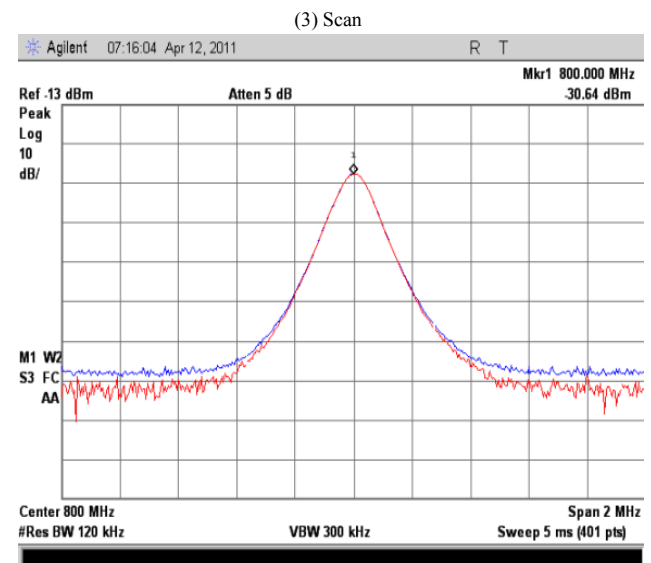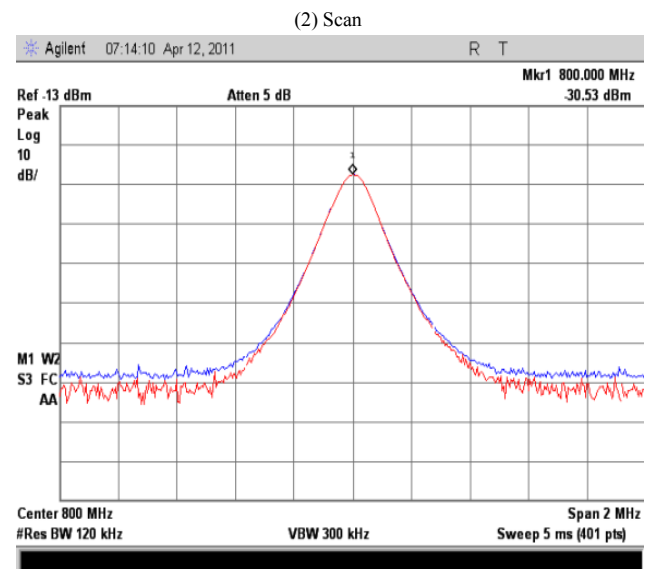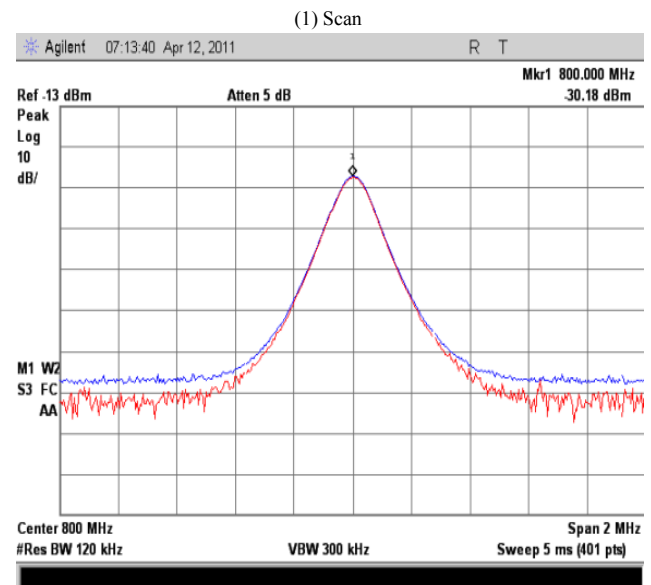
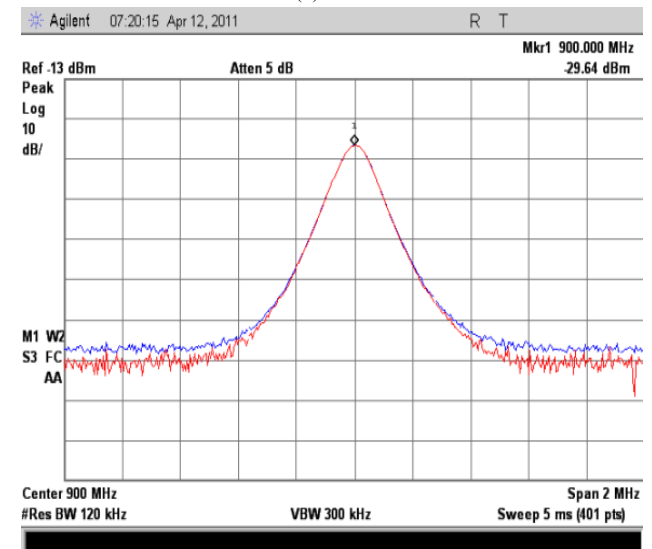(1) Scan
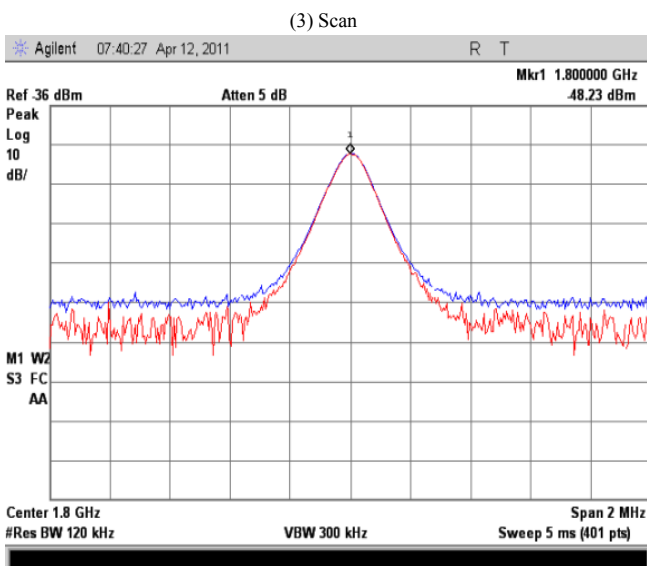

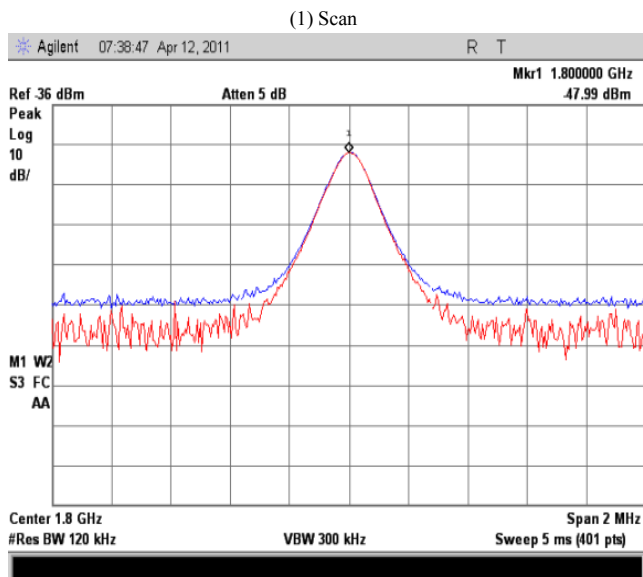(2) Scan

(3) Scan

800 MHz with MRET-Shield:

(1) Scan

(2) Scan

(3) Scan

900 MHz without MRET-Shield:

900 MHz with MRET-Shield:

(1) Scan

(1) Scan

(2) Scan

(2) Scan

(3) Scan

(3) Scan

1800 MHz without MRET-Shield:

(1) Scan

(2) Scan
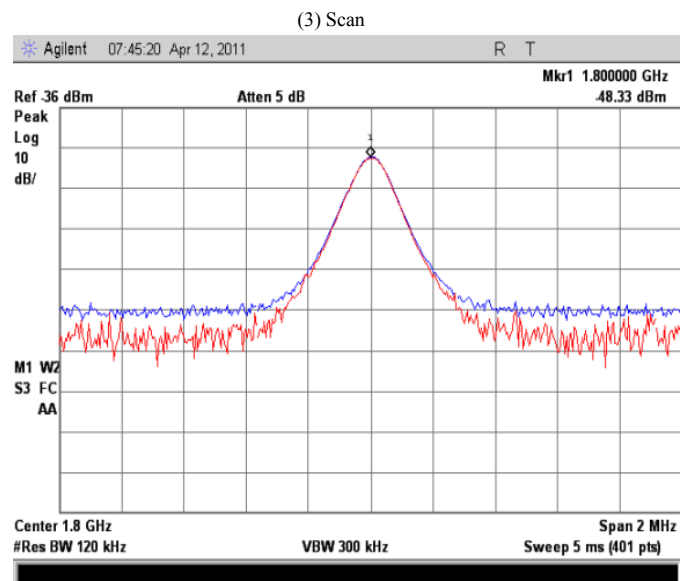

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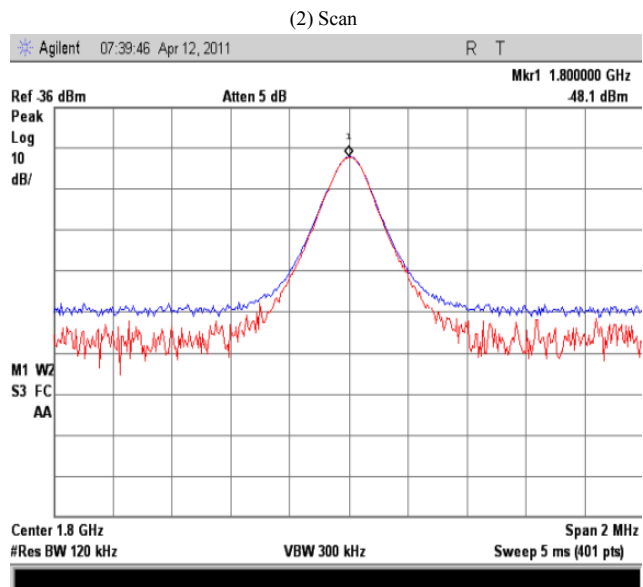
1800 MHz with MRET-Shield:
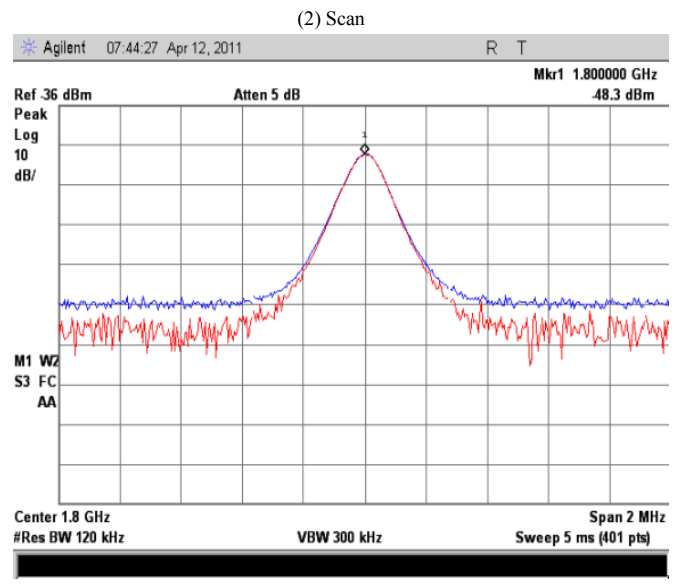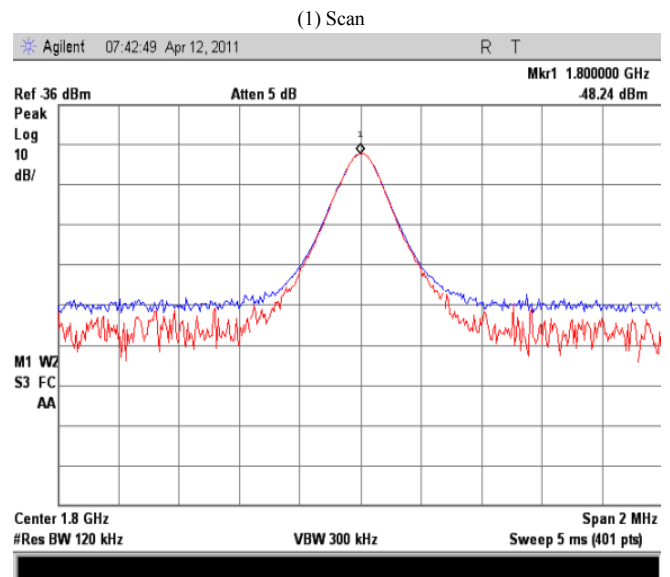
(1) Scan

(2) Scan

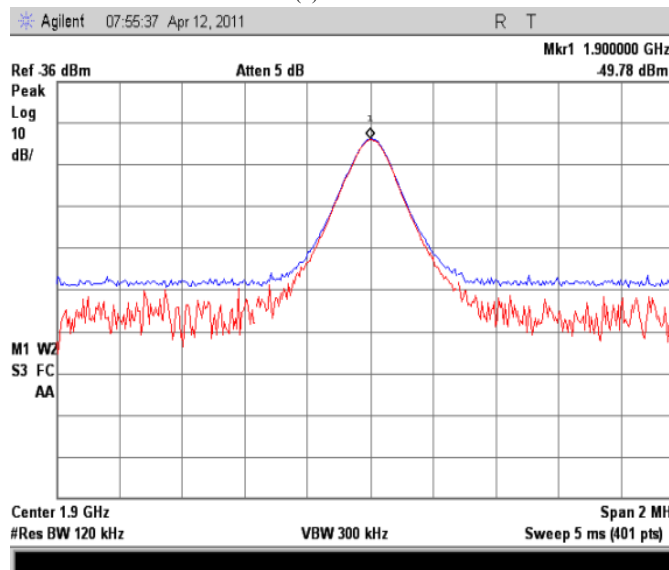(3) Scan

1900 MHz without MRET-Shield:

1900MHz with MRET-Shield:

(1) Scan

(1) Scan
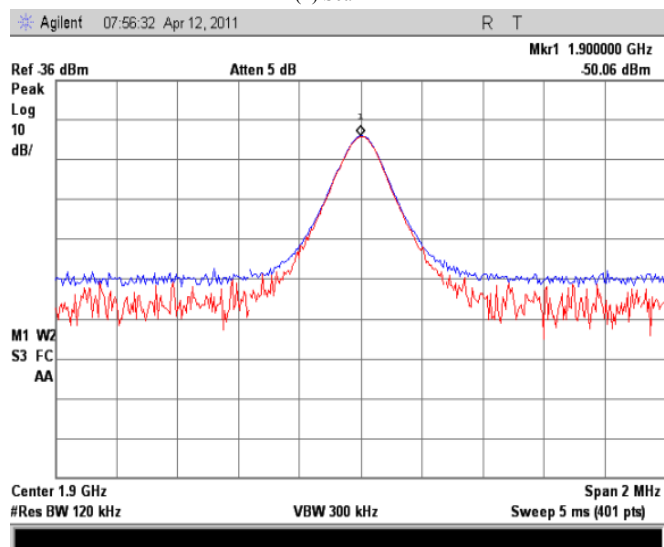

(2) Scan

(2) Scan

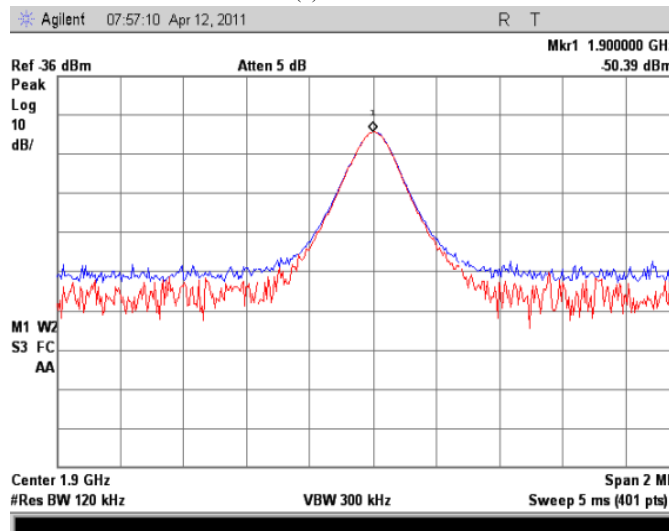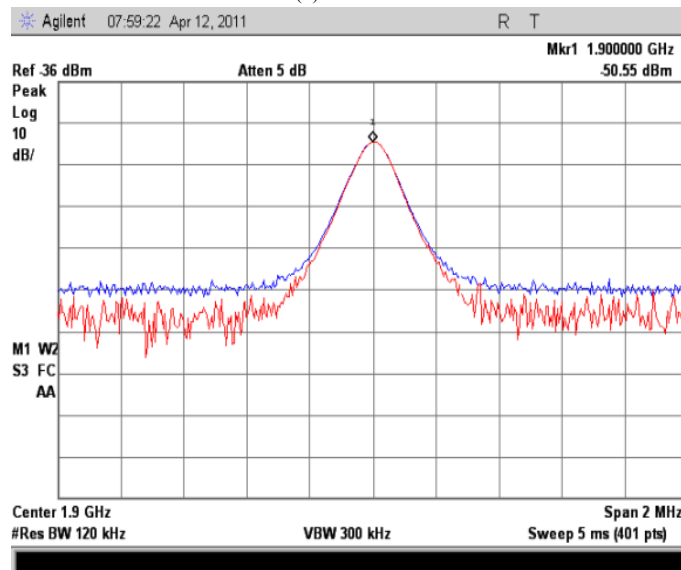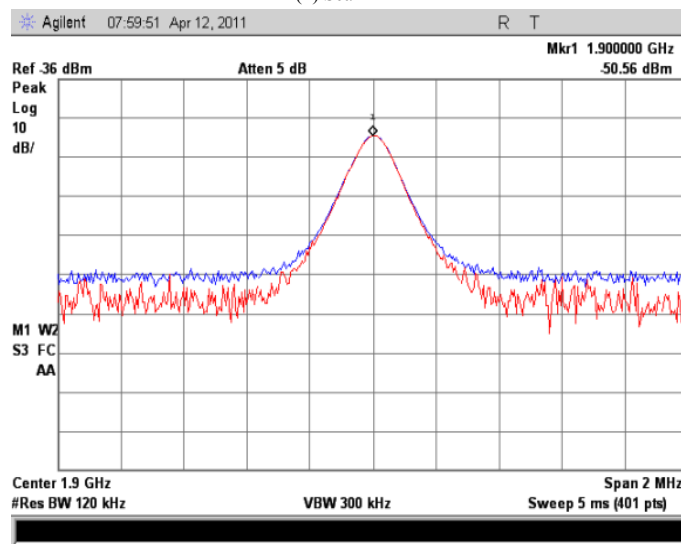(3) Scan

(3) Scan

2400 MHz without MRET-Shield:

(1) Scan
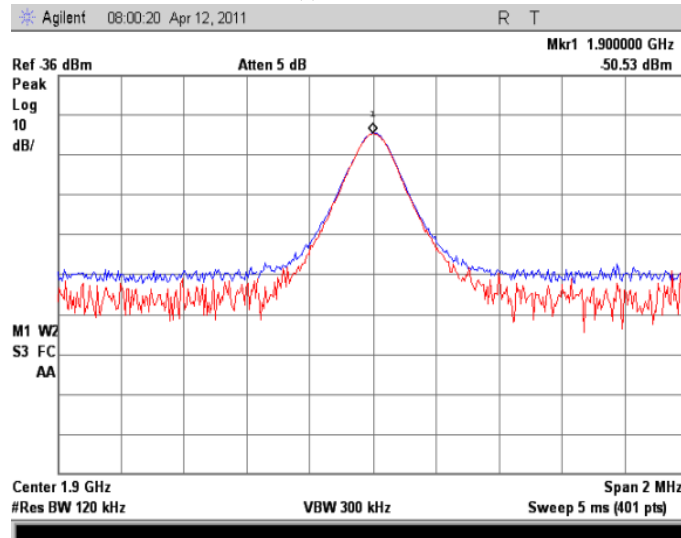

(2) Scan

(3) Scan
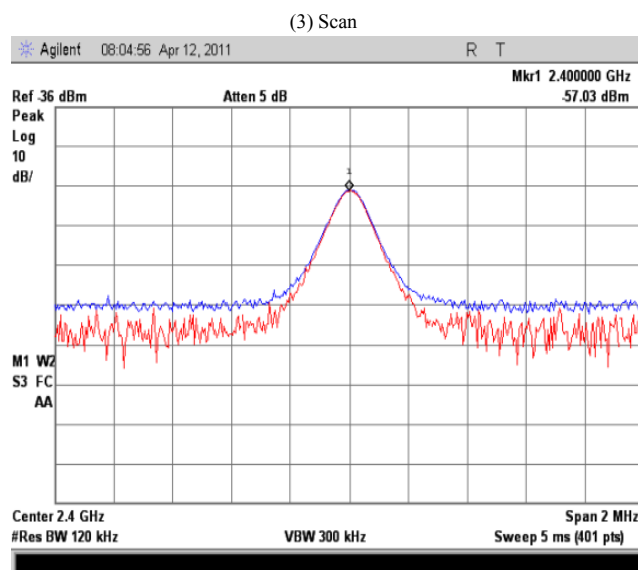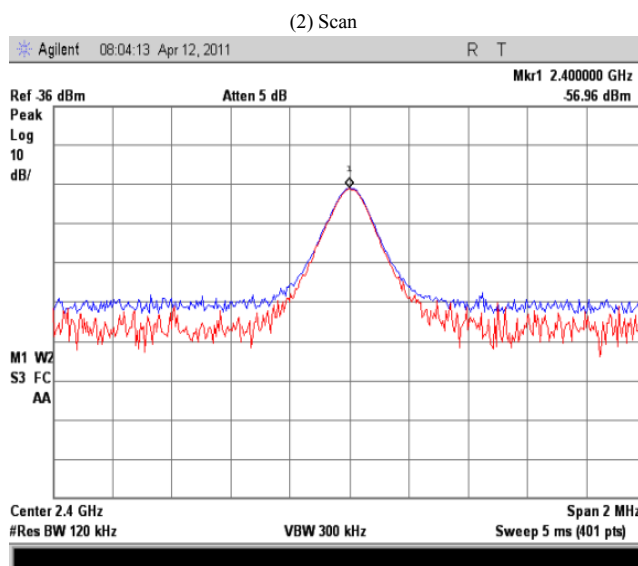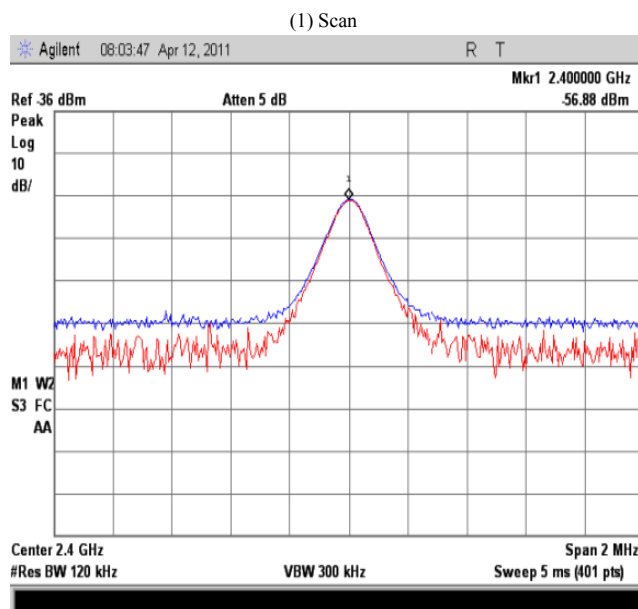
2400 MHz with MRET-Shield:

(1) Scan

(2) Scan

(3) Scan
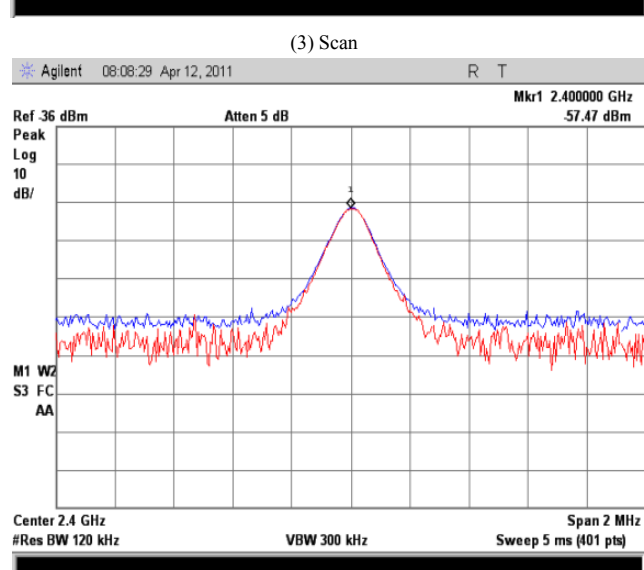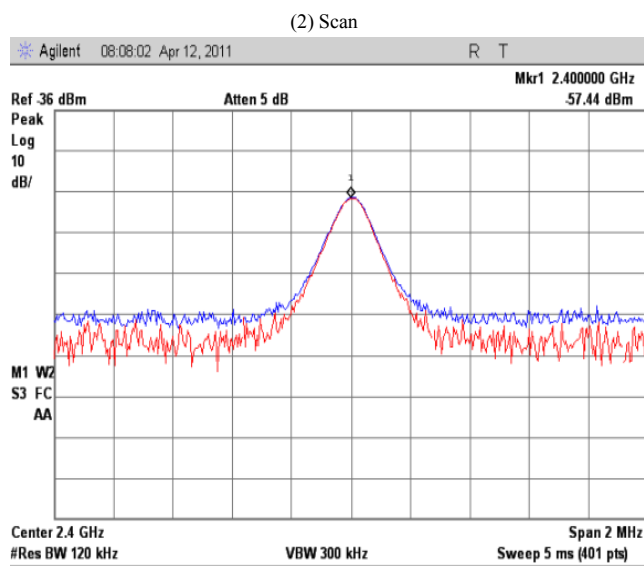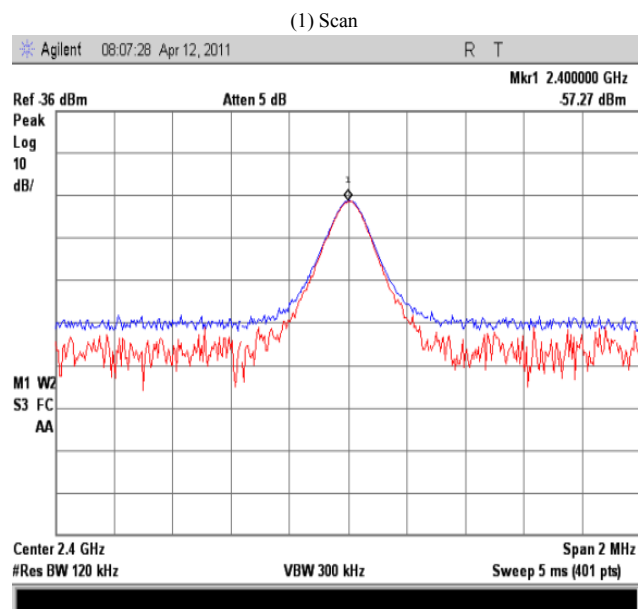
Based on results from Table 2 we can find out power gain of RF signals after MRET-Shield introduction, considering that level in dB = L = 10 x log(P_1/P_2). The suggested conversion gives the following results:

Table 3.

	ΔdB	Power gain (mW)
800 MHz	-0.33	0.9268
900 MHz	0.88	1.2246
1800 MHz	0.18	1.0423
1900 MHz	0.47	1.1142
2400 MHz	0.44	1.1066

Power gain of RF signals.

From engineering point of view these results clearly indicate that gain of received power is relatively small and the introduction of MRET-Shield polymer compound to the external RF field of 800 MHz, 900 MHz, 1800 MHz, 1900 MHz and 2400 MHz does not significantly affect the air measurements of microwave carrying signals. On another hand there was found a measurable gain of electric field strength and received power of microwave signals after the introduction of MRET-Shield polymer compound.

4. Discussion

The range of received power gain after introduction of MRET-Shield compound to the external microwave field in this experiment is significant enough to affect the morphology of living cell. A major contribution to this issue can be found in a critical study published in *Science* (Astumian and Weaver, 1990). These authors propose physical models according to which the cells are considered as detectors of very weak periodic magnetic fields and where the relationships between the size of the cell and the changes in membrane potential due both to temperature-induced fluctuations and to the application of electromagnetic fields are established. In the simplest version of the model, the calculation estimates at around 10^{-3} volts/cm the intensity of the minimum field to which the membrane macromolecules could be sensitive. However, if the model parameters considered take into account the so-called frequency "windows", i.e. the possibility that certain responses occur only within a restricted frequency band, then the theoretical intensity necessarily proves to be several orders of magnitude lower (10^{-6} volts/cm), thus closely approaching the data from various experiments in cells and animals. There is also evidence that cell proliferation activity is influenced by electromagnetic fields, despite the fact of very low intensity (0.2-20 mT, 0.02-1.0 mV/cm) (Luben *et al*., 1982).

To realize the mechanism of MRET-Shield polymer compound's effect regarding the gain of received power we consider the measurement of electric field strength with the help of Spectrum Analyser as following:

$$E = \sqrt{120\pi P} \qquad (1)$$

where: E – rms value of field strength in volt/meter
P – power density in watt/meter^2

120π – impedance of free space in ohms;
To determine the power received by the antenna, we multiply the power density by the received area of the antenna. The receiving area of the antenna is defined by equation:

$$A_r = \frac{G\lambda^2}{4\pi} \qquad (2)$$

where: G – antenna gain
λ – wavelength in meters;
The power received by the antenna is then defined by equation:

$$P_r = PA_r = \frac{PG\lambda^2}{4\pi} \qquad (3)$$

The equation (3) suggests that gain of received power after the introduction of MRET-Shield polymer to the external microwave field can be achieved as a result of increase of λ – wavelength of microwave signals only, since P – power density and G- antenna gain is constant for each set of measurements in this experiment.

The received power gain at given point enhances energy density of the electric field at this point and it is given by equation:

$$U = \frac{1}{2}\varepsilon \mid E \mid^2 \qquad (4)$$

where: ε is dielectric permittivity of the medium
E is electric field vector.
The total energy stored in the electric field in a given volume *V* is therefore:

$$U = \frac{1}{2}\varepsilon \int_V \mid E \mid^2 dV \qquad (5)$$

where: *dV* is differential volume element
Both equation (3) and (5) provide evidence that gain of received power after the introduction of MRE-Shield polymer compound to microwave field is a result of waveform modification of modulated microwave signal which in its turn leads to enhanced density of electric field and increase of modulated signal amplitude. It means the modification of resulting spectral components of microwave signal or another word amplitude modulation of microwave signal.
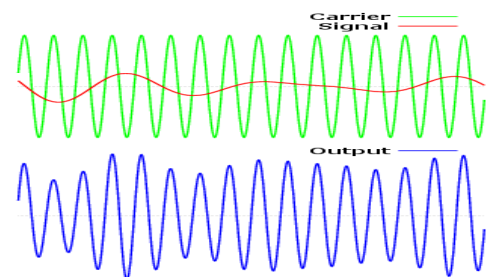
Picture 5. Amplitude modulated signal

Amplitude modulation consists encoding information onto a carrier signal by varying the amplitude of the carrier (Pic.5). Amplitude modulation produces a signal with power concentrated at the carrier frequency and in two adjacent sidebands. The lower sideband (LSB) appears at frequencies below the carrier frequency; the upper sideband (USB) appears at frequencies above the carrier frequency. The sideband power accounts for the variations in the overall amplitude of the signal. Realizing mentioned above it is possi-

ble to conclude that the introduction of MRET-Shield polymer compound to the external microwave field makes the resulting modulated spectral components of microwave field to resemble the characteristics of spatial incoherent field. It is an amplitude modulation process where random low frequency signal generated by MRET-Shield compound is a modulating signal and original microwave signal is a modulated one.

How does the electromagnetic field affect the biologic system? Litovitz *et al.* proposed that living cells exist in an electrically noisy environment and these endogenous thermal noise fields are larger than those exogenous EMFs reported to cause effects. They suggested that only the EMFs that are temporally and spatially coherent such as radiofrequency fields could affect living cells while endogenous thermal noise fields, which cells do not respond to, were temporally and spatially incoherent. Coherence was an essential character for EMFs to cause bioeffects, which means the characteristic parameters of EMFs are constant over a period of time ($> \sim 10$ s). It was speculated that when an incoherent random noise field is superimposed on a coherent EMF signal, any observed EMF-induced bio-effects would be suppressed. A number of observations have supported this theory. In one experiment, the cellular effects induced by acute microwave radiation were mitigated by superposing with electromagnetic noise *in vitro*. DNA damage induced by 1.8 GHz microwave radiation at the SAR of 3 W/kg and 4 W/kg was significantly higher than sham exposure ($p<0.001$) whereas no significant differences could be observed in other exposure groups compared with the sham exposure group ($p>0.05$). Electromagnetic noise alone did not increase DNA damage of HLEC, and when it was superposed on the radiofrequency field, the electromagnetic noise could block RF-induced DNA damage (Ke Yao, *et al,* 2008). Another experiment demonstrated that microwave fields, amplitude modulated by an extremely low-frequency (ELF) sine wave, can induce a nearly twofold enhancement in the activity of ornithine decarboxylase (ODC) in L929 cells at SAR levels of the order of 2.5 W/kg. Similar, although less pronounced, effects were also observed from exposure to a typical digital cellular phone test signal of the same power level, burst modulated at 50 Hz. It has also shown that ODC enhancement in L929 cells produced by exposure to ELF fields can be inhibited by superposition of ELF noise (Litovitz et al., 1997).

A number of experiments (Smirnov, 2009; Fisher et al, 2002, 2008) prove that the introduction of MRET-Shield polymer compound to microwave radiation can mitigate EMF-induced bio-effects associated with human exposure to RF electromagnetic fields. The results found in these experiments confirm that MRET-Shield compound introduced to external RF signals can modulate spectral components of microwave field in a way to eliminate unwanted bio-effects.

5. Conclusions

Test conducted at MET Laboratories, Inc. confirms that the introduction of MRET-Shield polymer compound to external RF signals of 800 MHz, 900 MHz, 1800 MHz, 1900 MHz and 2400 MHz leads to the measurable power gain of microwave field as a result of the superposition of low frequency noise field generated by MRET-Shield compound and microwave carrier signals. This superposition phenomenon can be realized as RF field spectral components amplitude modulation process. This test also confirms that the introduction of MRET-Shield polymer to the source of RF signals in the range of 800 MHZ, 900 MHz, 1800 MHz, 1900 MHz, and 2400 MHz does not significantly affect the air measurements of RF signals, and subsequently does not lead to any significant distortion of transmitted RF signals. It is because found power gain and modification of resulting field spectral components are insignificant from engineering point of view. On the other hand, the range of found received power gain and amplitude modulated spectral components of resulting RF field suggests that such modulated RF signal can affect living cell morphology and mitigate EMF –induced bio-effects *in vitro*.

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