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ANALYSIS OF ATTENUATION EFFECTIVENESS OF ANTI-RADIATION PHONE SHIELDS

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ABSTRACT

The analysis of 11 mobile phone anti-radiation stickers to determine their radiofrequency (RF) attenuation effectiveness was conducted in the laboratory. A spectrum analyser, coupled to a power metre, was used to test the stickers on a basic phone and a smartphone in a Faraday cage. The results showed no exposure reduction properties of the stickers. However, the presence of the stickers on the phone rather led to over a 300,000 % increase in emitted phone RF power and a relatively lower percentage increase by the smartphone.

Keywords: Attenuation, Electromagnetic Fields, Anti-Radiation Phone Sticker, Radiofrequency Radiation, Mobile Phones

INTRODUCTION

On January 11 and September 10, 2021, the British Broadcasting Corporation (BBC) published news items on anti-radiation phone stickers sold on the online retailer Amazon. Promoters of these stickers claim it protects users against electromagnetic fields (EMF) from mobile phones. However, the Advertising Standards Authority (ASA) of Britain criticised these claims. The news items also indicated that scientists have told BBC that, these products do not reduce a phone user's radiofrequency (RF) radiation exposure from the mobile phone. In the report, the University of Surrey tested smartDOT stickers on mobile phones and Wi-Fi access points, resulting in no evidence of a reduction in RF exposure (BBC, 2021). Biological testing was not included in the test, even though it would have provided the harmonising effect of the stickers. The Federal Trade Commission (FTC, 2011) advises consumers against such products, suggesting that their usage could cause the phone to emit more RF radiation.

Several such products have found their way into the Ghanaian market space by importation and are mostly illegally sold at exorbitant prices to unsuspecting buyers. Their sponsors make varied claims of over 99% reduction in RF radiation exposure from mobile phones and the healing of some ailments, among others. There have been fraud cases reported to the police involving the sale of such products. Most of these products do not come with user instructions.

Mobile phones sold on the market are classified according to their permitted or allowable transmitted output power values. These maximum output powers are not always used in a network. Based on the intermittent measurements done by the phone, the Base Transceiver Station (BTS) instructs the phone to either increase or reduce its output power. During a call, the power level should be only optimal or sufficient to maintain good signal quality, which is controlled via commands sent by the BTS to the phone. This Automatic Power Control (APC) is key to reducing interference with other users, thus improving the system's performance as well as prolonging the battery life of the mobile phone (Das, 2010).

This study assesses the RF attenuation (RF exposure reduction) abilities of anti-radiation phone stickers and provides critical baseline data for professionals, the public and the scientific world. The work serves as baseline data for regulators in Ghana.

MATERIALS AND METHODS

A power meter, which is coupled with a log-periodic antenna, is connected to the spectrum as the measurement setup. The spectrum analyser is an Anritsu Spectrum Master MS2720T with serial number 1508082 and a frequency range of 9 kHz to 43 GHz. It is coupled to a handheld Transformational Security log-periodic antenna TS-6021 with serial number 00302 and a frequency range of 80 MHz to 3 GHz via the Anristu power metre MA24108A of 10 – 18 GHz range over 60 dB of dynamic range. The tests were done over the frequency bands of 900 MHz, 1800 MHz and 2100 MHz in an electromagnetic shielded cage (Faraday cage) to reduce interference. The Faraday cage has dimensions of 2.2 m in width, 1.9 m in breadth, and 2.0 m in height.

In testing the RF attenuation capability of the anti-radiation stickers, the sticker is attached to the back of the phone as described by the user instructions that come with the product. Measurements were done with and without the sticker attached in both receiving and dialling modes. Two mobile phones- a smartphone and a basic phone, were used in the test. Influencing factors such as call time, battery life, and distance of the phone from antenna were held constant to ensure they did not unduly affect the emitted RF power of

the phones. The mobile phones were charged fully before every test. In the Faraday cage, the phones were placed in the same position at 0.3 cm from the antenna to maintain a constant distance between the phone and the antenna. A 30-second time interval for each test phone call was maintained throughout. Ten readings of measured RF Power were recorded for each measurement, and the measurements were repeated twice. Three samples of each of the 11 products were used in conducting the tests. Attenuation was evaluated by taking the difference between the recorded RF power levels when there was no anti-radiation sticker on the phone, and the RF power levels when the sticker was attached to the phones.

RESULTS AND DISCUSSIONS

Figure 1 shows the output RF levels of the phones without the stickers attached. Generally, the stickers showed no RF attenuation or reduction properties. Rather, their presence on the phone caused several-fold increases in RF power as shown in Figures 2 - 4. A negative attenuation indicates an increase in RF power instead of a decrease. The expanded uncertainty associated with measured values is 14.14 %.

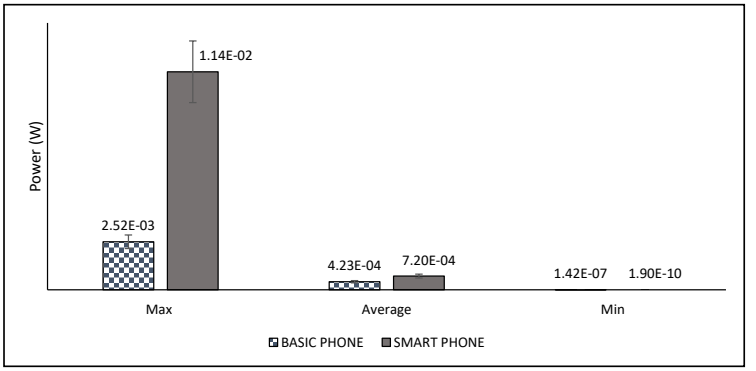

Figure 1: Phone without anti-radiation stickers (Background).

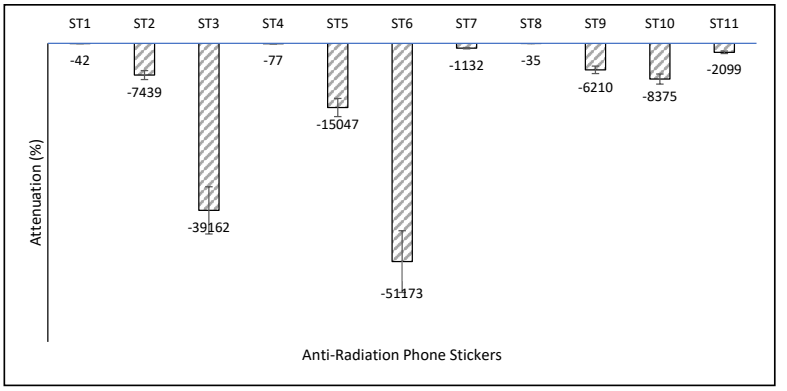

Figure 2: Percentage Average Attenuation Produced by the Anti-Radiation Stickers

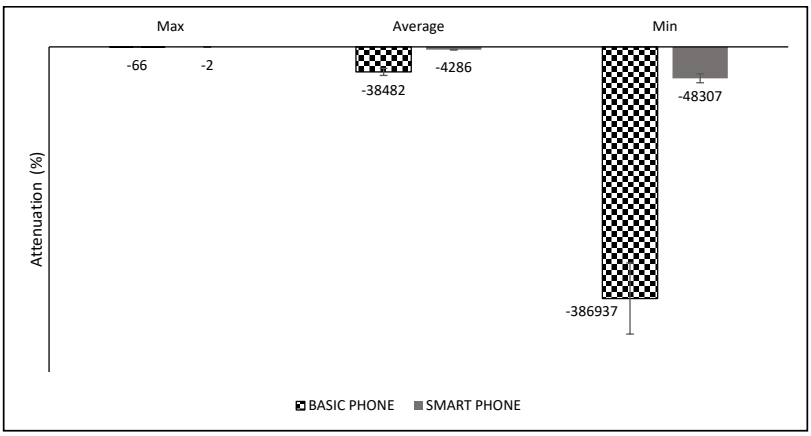

Figure 3: Percentage Attenuations for Dailing and Receiving with Anti-Radiation Stickers Attached

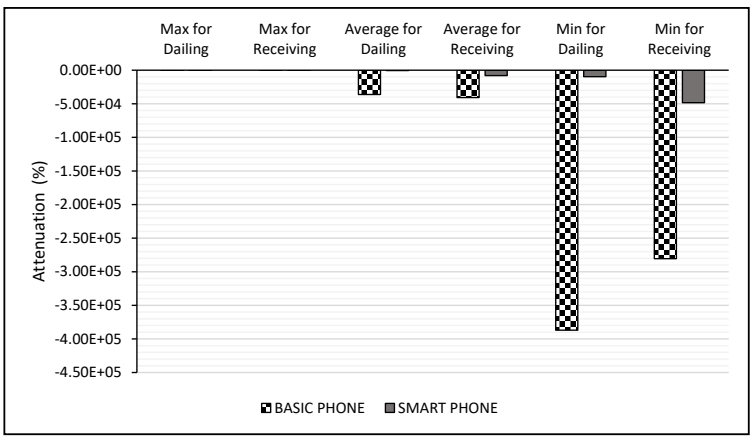

Figure 4: Maximum, Average and Minimum Attenuation for the Basic and Smart Phones with Anti-Radiation Stickers Attached

The names of the 11 anti-radiation phone stickers used in the study were coded with alphanumeric letters from ST1 to ST11. Figure 2 shows the percentage attenuation of the individual anti-radiation stickers, Figure 3 gives the maximum, average and minimum attenuation recorded, while Figure 4 provides a summary of the attenuation in terms of when dialling or receiving calls. Figure 1 is the RF power levels summary measured from the phones without the anti-radiation stickers attached.

As demonstrated in Figures 2 to 4, the presence of the anti-radiation stickers caused major increases in the emitted RF power of the mobile phones. The anti-radiation phone sticker ST6 produced the worst-case attenuation, by causing an increase in RF power levels to over 40,000 times as seen in Figure 2. All the anti-radiation phone stickers caused a negative attenuation ,indicating that their presence on the phone increased RF exposure to the user instead of a reduction. In Oliver et al. (2003) and FTC (2011), they

found the stickers ineffective in reducing user exposure and suggested their use can cause increases in RF exposure.

In normal usage, the front part of the phone faces the user. Therefore, the placement of the sticker behind the phone (as directed by the user manuals) diminishes its role of shielding the user from the emitted radiation from the phone, even if it is effective in attenuation. The antenna of the phone does not emit RF radiation directionally, but isotropically. Hence, placing the small anti-radiation sticker at the back of the phone is unlikely to be an effective shield, even assuming it is an effective attenuator. The presence of the sticker can interfere with connectivity and signal quality, and lead to the phone raising its emitted power to attain good signal quality, potentially leading to an increase in exposure to the user.

Even though the background (i.e., without the presence of the anti-radiation stickers) RF power levels of the smartphone are higher as seen in Figure 1, interestingly, it appears to produce less RF increases relative to the basic phone as demonstrated in Figures 3 and 4. It was also observed that higher RF increases were produced when receiving calls, compared to dialling calls. Figure 4 demonstrates this observation.

Similarly, a lower increase in RF power was recorded with the smartphone relative to the basic phone as observed in Figures 3 and 4. This could be attributed to lower power levels recorded by the smartphone, as shown in Figures 6 and 7. A possible reason could be that the smartphones had a better APC algorithm. Figure 5 provides the average power produced during the test with anti-radiation phone stickers attached to the phones. The product ST4 which has the highest average RF power is one of the common anti-radiation phone stickers in the Ghanaian Market.

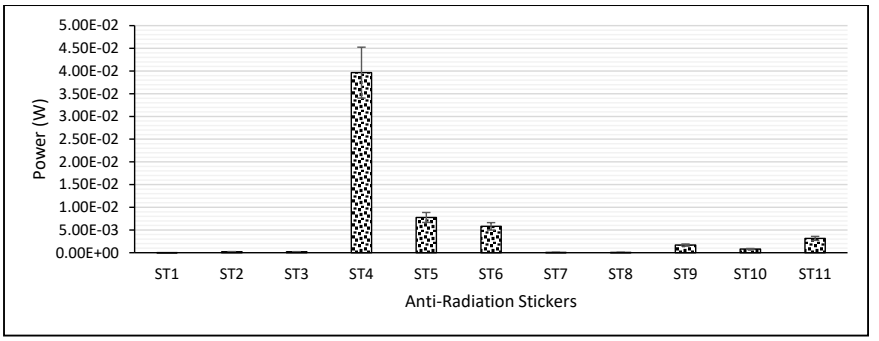

Figure 5: Average Power of the Phones with the Anti-Radiation Stickers

Clearly, from Figures 6 and 7, the basic phone produced relatively higher power levels relative to the smartphone when the anti-radiation stickers were attached to the phones. This could be attributed to differences in antenna type and characteristics of the phones as explained by Osei et al. (2022). And dialling mode produced lower power levels when the stickers were attached compared to the receiving calls mode.

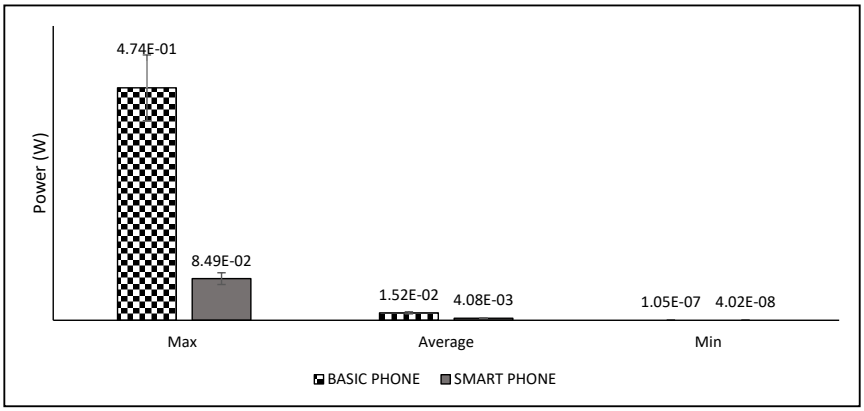

Figure 6: Maximum, Average and Minimum Power Levels Produced with the Anti-Radiation Stickers

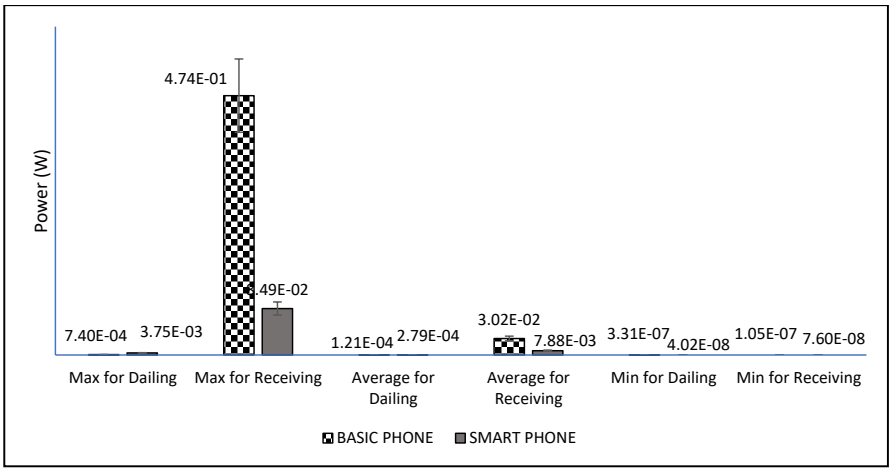

Figure 7: Power Levels of Basic and Smart Phones when Dialling or Receiving with Anti-Radiation Sticker Attached

The statistical summary of the attenuation values is presented in Table 1. The distribution of the attenuation values has a negative skewness, showing the higher increases in RF power. The negative mean value confirms the non-positive attenuation characteristic nature of the anti-radiation stickers. The huge variance value throws further light on the high variation of the measured values. As observed, due to the skewness of the data, the median value is closer to the mode value than to the mean value. Hence, compared to the mean value, the -99.91% median value better represents the average of the measurement results. As such, the mean value of -17060.35% may not be a good representation of the data.

Table 1: Statistical Summary of Percentage Attenuation Values

Statistic	Value
Mean	-17060.35
Standard Error	5996.92
Median	-99.91
Mode	-100
Standard Deviation	56891.86
Sample Variance	3236684791
Kurtosis	25.37
Skewness	-4.82
Range	386934.73

CONCLUSION

The results of the RF attenuation test on 11 anti-radiation phone stickers showed no attenuation capabilities. Rather, the presence of the stickers on the phones causes increases in the RF power output of the phones. The Anti-Electromagnetic Radiation products had no RF exposure reduction capabilities and are ineffective in shielding RF exposure to the user from mobile phones.

The smartphone produced lower RF power increases with the stickers attached compared to the basic phone. Also, lower power increases were produced during dialling calls relative to receiving calls. The increase in RF power recorded could be due to the anti-radiation stickers interfering with signal connection and hence causing the phone to increase its RF radiating power in order to maintain appreciable connectivity. Using the Specific Absorption Rate (SAR) test will enhance the results obtained. The results correlate with some previous works, that the shields are ineffective in reducing exposure to the head.

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Declaration of Competing Interest

The authors declare no conflict of interest.

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