# Optimization of Mild Microwave Hyperthermia Interconnection with Targeted Delivery of Nanoparticles

Dagmar Faktorová, Mária Pápežová

Faculty of Electrical Engineering, University of Žilina, Univerzitná 1, Žilina, Slovak Republic, e-mail: dagmar.faktorova@fel.uniza.sk

***Abstract*** **The paper deals with interconnection of microwave hyperthermia with controlled biodistribution of nanoparticles in order to maximize the exposure tumorous tissue and minimize heating the neighbouring healthy tissue. We investigated in our research the delivering nanoparticles to the tumorous tissue as a function of time in order to optimize the beginning of microwave hyperthermia treatment. We also follow the other parameters which could affect the effect process of microwave hyperthermia.**

***Keywords*** **Microwave hyperthermia, nanoparticles, liposomes, drugs delivery.**

## I. INTRODUCTION

Mild microwave hyperthermia comes under emerging therapeutic methods in oncology which effect is not in destruction of cancer cells but in improving the effectiveness of chemotherapy or radiotherapy. One of the major problems connected with microwave hyperthermia in general is the achievement very precise beam focusing to the volume of treated tissue in the case of local microwave hyperthermia.

Nanotechnology become as one of the next promising and important methods in the process of diagnostics and treatment of cancer diseases. The therapeutic effect of nanoparticle using is connected with very precise selective heat deposition directly in tumorous cells. In this way there is possible to affect the process of pharmacodynamics in the in terms of increasing of drug concentration in cancer cells.

In our research we connect the mild microwave hyperthermia with temperature sensitive liposome application. Liposomes acts in two roles: to delivery drug in tumorous cells and in the role of highlossy dielectric carrier (HDC). HDC delivered to the tumour volume increase the focusing effect of microwave energy.

It is very important to know the optimal time for mild microwave hyperthermia application regarding to time dependent administration of liposomes delivery to the tumour volume. We have used the pharmacokinetics mathematical model, where the variation of parameters (time, surface charge, concentration of agent - nanoparticles, frequency of agent – nanoparticles rendering, type of agent - nanoparticle) allowed us to appoint the optimal time of mild microwave hyperthermia setting-in and its duration after addressing the drugs and nanoparticle covered by liposomes into the patient body.

## II. NUMERICAL RESULTS

We have used in our research the two kind of liposomes – in the role of higlossy dielectrics and in the role of chemotherapy drug carrier and followed up their uptake in tumorous tissue and their biodistribution. We have chosen liposomes, which are able to be accumulated in tumorous tissue. Very important factor connected with uptake of nanoparticle agent in tumorous tissue volume is surface charge of nanoparticles and also the frequentness of nanoparticles drugs administration. We follow up in mathematical analysis the intersection of curves biodistribution of both liposomes into tumorous tissue. This time we marked as a setting-in time for application of microwave hyperthermia.

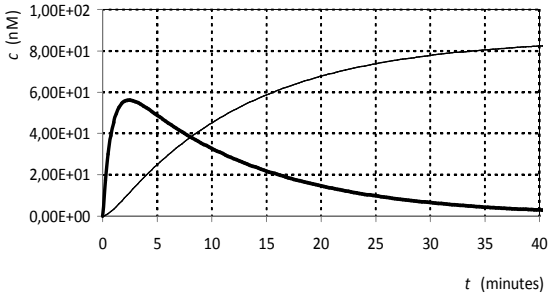


Fig. 1. The assessment of optimal time MW hyperthermia setting-in

In Fig. 1 are results of analysis the nanoparticle uptake in tumorous tissue. The optimal time for microwave hyperthermia starting – 8min – was calculated and was set in the point of intersection of two curves. The course of curves in Fig. 1 was calculated by using mathematical pharmacokinetics model with compartments which represent tumorous tissue and blood stream: slim curve represents the metabolism of liposomes in the role of carrier of highlossy drugs and second one represents the metabolism of liposomes in the role of carrier chemotherapy drugs.

## III. CONCLUSION

Our results showed, that microwave hyperthermia can become very effective tool for increasing effectiveness of chemotherapy which used temperature sensitive liposomes in the role of drug carrier.

## IV. ACKNOWLEDGEMENTS

This work was done and has been supported from project VEGA No. 1/0846/13 and from project founded by EU Innovation and Internationalization of Education - Instruments to Increase the Quality of the University of Žilina in the European Educational Area, ITMS 26110230079.

## V. REFERENCES

[1] Strogatz, S. H.: ”Nonlinear Dynamics and Chaos with Application to Physics, Biology”, Addison – Wesley, 1994.