ISSN 2459-1149 SHSR journal

JOURNAL OF SOCIAL AND HUMANITIES SCIENCES RESEARCH

Uluslararası Sosyal ve Beşeri Bilimler Araştırma Dergisi

Open Access Refereed e-Journal & Refereed & Indexed

Article Type	Research Article	***Accepted / Makale Kabul***	30.10.2019
Received / Makale Geliş	25.08.2019	***Published / Yayınlanma***	31.10.2019

ANALYSIS OF THE MOST PERFORMANCE POLYMER MATERIALS WITH THE QUALIFIED DECISION METHOD FOR NEURAL IMPLANTS[1]

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Doi Number: http://dx.doi.org/10.26450/jshsr.1530

Reference: Uçar, U. & Balo, F. (2019). Analysis of the Most Performance Polymer Materials with the Qualified Decision Method for Neural Implants. *Journal of Social and Humanities Sciences Research, 6*(43): 3261-3265.

ABSTRACT

Neural Implants are electronic devices that stimulate parts of the nervous system and record the electrical activity of nerve cells by sending electrical shocks to the areas of the brain that have lost their function with the help of a battery-powered technical device placed under the scalp. With the help of these devices, it is tried to be activated by stimulating the nerves that have lost their function due to any illness or accident. Nowadays, neural implants; it is used extensively in the treatment of many diseases such as facial paralysis, Parkinson's disease, Alzheimer's disease, psychiatric disorders and drug addictions. Researchers are working hard to develop and generalize these devices. In this study, some of the most commonly used polymer materials in the development of neural implant materials are analyzed thermo-mechanically by using qualified decision method. With the multi-criteria analysis, the most performance polymer material for neural implants has been determined.

Keywords: Neural Implant, Thermo-mechanical, Multi Criteria Decision Making, Qualıfied Decısıon Method

1. INTRODUCTION

Thanks to technological advances in the health sector, easy and practical solution approaches have been developed for untreated diseases. Neural implants are devices developed in this context, and more than 100,000 people around the world survive thanks to neural implants (URL.1). Thanks to these batteries placed under the scalp, the nerves that cannot function due to an illness or accident become active again by making electrical stimulations. In this way, senses, physical movements and memory develop. In order to restore cognitive function, the neural implant must collect data from a region of the brain. Once these data have been processed correctly, the signals obtained should be transmitted to another area of the brain without touching the damaged tissues. The electronic packages in each device are activated by a series of small electrodes that interact directly with healthy neurons within the body. As a result, it is a two-way flow of information between the neural interface and the nervous system. These connections can occur at several levels, including preferential nerves in the spinal cord and the brain (URL.2). Nowadays, neural implants are used extensively in the treatment of diseases such as Parkinson's, chronic depression, Alzheimer's, resistant epilepsy, re-sensing the related limbs such as arm or leg paralysis, psychiatric disorders and drug addictions (URL.3). In addition, thanks to neural implants, intensive studies are being carried out on the treatment of psychiatric diseases without medication, improving memory and sensing bionic prostheses by patients (URL.4). The choice of the ideal polymer material

[1] Bu çalışma, 6-8 Eylül 2019 tarihlerinde Şanlıurfa'da düzenlenen 1. Uluslararası Multidisipliner Çalışmalar ve Araştırmalar Kongresi'nde sunulmuştur.

for the production of neural implant materials is of great importance. In this study, alternative polymer materials are analyzed in detail thermo-mechanically and it is aimed to contribute to the production of durable neural implant materials. Analytical Hierarchical Process (AHP) methodology, one of the Multi Criteria Decision Making methods, was used to select the ideal material.

There are many studies in the literature on AHP. This article provides information about the application of the related method on the health sector. Doğan and Gencan have developed a hybrid solution approach using Data Envelopment Analysis and AHP methodology in order to determine the relative effectiveness of public hospitals in Ankara (Doğan, & Gencan, 2014). İnce et al., used the AHP method to select the appropriate site for the hospital (İnce, Bedir & Eren, 2016). Kıdak et al., tried to determine the satisfaction, needs and expectations of patients from the services provided in the health sector by using the Quality Function Deployment and Fuzzy AHP methods (Kıdak, Arslan & Burmaoğlu, 2016). Aslan and Sezgin tried to determine the success performance of private hospitals and the parameters affecting this performance by using AHP method (Aslan & Sezgin, 2017). Aydın has determined the ideal location for hospital investment by using the Fuzzy AHP method (Aydın, 2009). Emeç and Akkaya used the NASA Task Load Index (NASA-TLX) measurement method and Analytical Hierarchy Process (AHP) method to determine the mental workload of the doctors working in the hospital (Emeç & Akkaya, 2018). Önder et al., prioritized the stress factors in nurses by using AHP method (Önder, Aybas & Önder, 2014). Ucar and Balo determined the ideal metal dental implant material for human health using AHP method (Uçar & Balo, 2018). Turan and Turan tried to solve the problem of nurse selection by using AHP method (Turan & Turan, 2016). Hafezalkotob and Hafezalkotob used Target-Based Multimoora method for material selection in biomedical applications (Hafezalkotob & Hafezalkotob, 2015). Das et al., used the WPM (Weighted Product Method), AHP and TOPSIS methods for selecting materials for hip implants (Das, Chakraborti, Bhowmik & Singh, 2019). Özüdoğru, prioritized the criteria affecting the selection of ultrasound devices using AHP method (Özüdogru, 2018). They used expert systems to select the appropriate material for optional implants (Ristić, Manić, Mišić, Kosanović & Mitković, 2017). Venkatesan et al., Tried to determine the ideal among alternative microenculations by AHP method (Venkatesan, Muralidharan, Manavalan & Valliappan, 2009). Voudrias used the AHP method to select the appropriate technology for infectious medical waste treatment (Voudrias, 2016)

In this article, the polymer materials used in the production of neural implants are analyzed in terms of thermo-mechanical criteria and the ideal polymer material is determined by AHP. In the second part of the study, the criteria and alternatives discussed in the article are defined. In the third section, the solution methodology used is expressed and the application study is made in the fourth section. In the fifth chapter, evaluations about the study were made.

2. PROBLEM

Many materials can be used in the production of neural implants which may have different technical properties. In this study, polymer materials used in neural implants were analyzed in terms of technical and mechanical properties. The polymer materials used in the study and the criteria to be considered in the evaluation of these materials are shown in Figure 1.

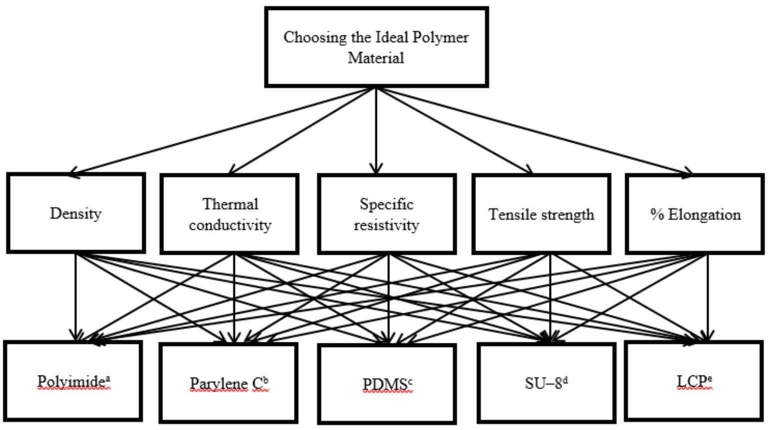

Figure 1. Decision Tree for Neural Implant Selection

The technical information about the decision tree in Figure 1 is shown in Table 1.

Table 1. Information About Alternative Polymer Materials and Selection Criteria (Hassler, Boretius, Stieglitz, 2011).

	Alternatives				
Criteria	**Polyimide**[a]	**Parylene C**[b]	**PDMS**[c]	**SU–8**[d]	**LCP**[e]
Density (g/cm3)	1.10–1.11	1.289	1.08	1.075–1.238	1.4
Thermal conductivity (W/cm K)	0.29	8.2	15–25	0.002–0.003	0.283
Specific resistivity (X cm)	> 10^{16}	> 10^{16}	10^{15}	7.8 x10^{14}	1 x10^{13}
Tensile strength (MPa)	392	69	6.2	60	182
Elongation (%)	30	200	600	4.8–6.5	3.4

In the fourth section, this decision tree and AHP method will be used to select the ideal polymer material.

3. METHODOLOGY

Analytical Hierarchical Process method developed by Saaty is a multi-criteria decision making method that allows to evaluate alternatives by considering criteria and criteria by considering the purpose (Saaty, 1980). The problem consists of six steps and these steps are described in the following items. (Uçar & İşleyen, 2019).

Step 1. Defining the properties of the problem and forming the relevant decision tree.

Step 2. Establishing the comparison matrix of criteria.

Step 3. Calculation of relative weights for criteria.

Step 4. Measurement of the consistency value of the criterion comparison matrix.

Step 5. Determining the importance of alternatives based on each criterion.

Step 6. Determination of importance level of alternatives and determination of ideal alternative.

4. APPLICATION STUDY

The problem mentioned in Chapter 2 was solved by taking the expert opinions into consideration and using the AHP method with the help of the Expert Choice program. In the first step of the AHP method, the criteria were compared and the relative weights obtained were shown in Figure 2.

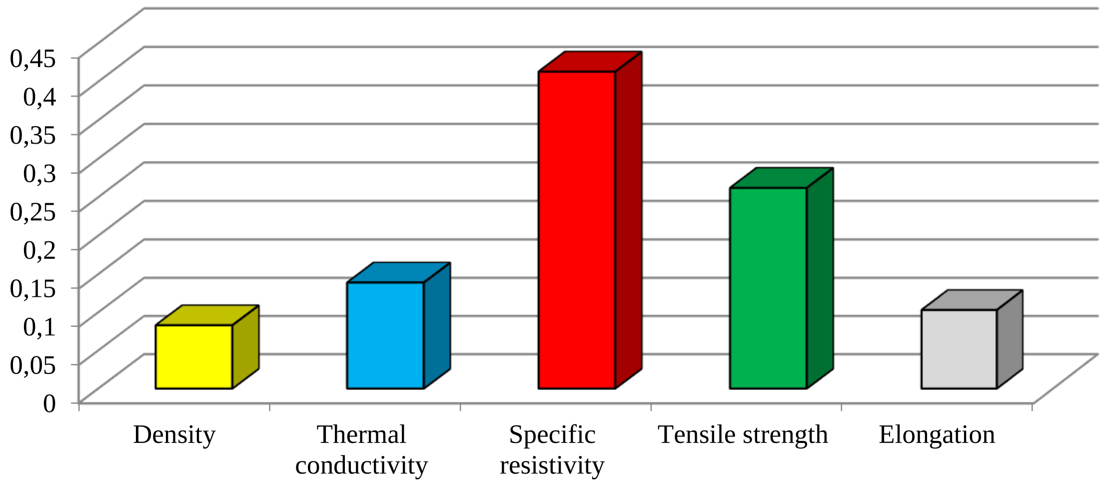

Figure 2. Priority Values of Criteria

The most important criterion according to the criterion priorities in Figure 2 is “Specific resistivity”. Following this criterion, the “Tensile Strength” and “Thermal Conductivity” criteria are listed. It is understood from the results that "Density” criterion has the least important on thermo-mechanical properties. In addition, the consistency value of the criteria comparison matrix was found to be 0.08, and since this value was less than 0.1, the matrix was found to be consistent. Alternative priority values have been determined by taking into account the identified criteria priorities and the results of the analysis are shown in the Figure 3.

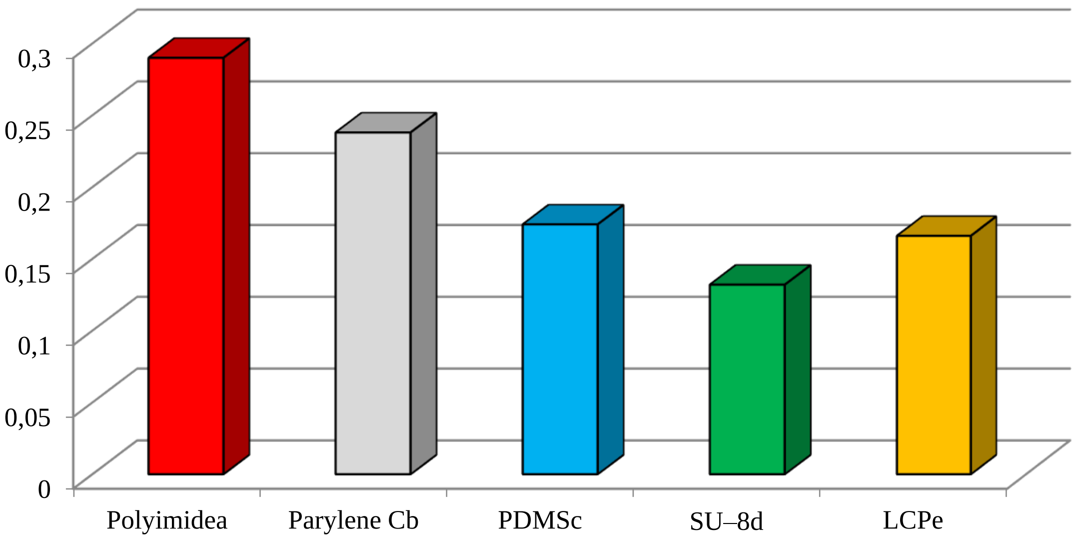

Figure 3. Importance Values of Alternatives.

According to the alternative priority values in Figure 3, the Polyimide[a] alternative was determined as the ideal polymer material in terms of thermo-mechanical criteria. This material was followed by Parylene C[b] and PDMS[c] alternative, respectively. In addition, it was understood from the results that SU–8[d] ve LCP[e] alternatives are two low-important criteria. In addition, the consistency value was calculated as 0,07.

5. CONCLUSION

Neural implant materials placed under the scalp and reactivating the deformed points of the brain with the electrical signals they emit are used extensively in the treatment of many diseases. Alzheimer's, psychiatric disorders, epilepsy and paralysis are examples of some of these diseases. In addition, researchers work hard on the use of neural implants for memory enhancement, treatment of psychiatric disorders, and orientation of prosthetic organs. Since neural implant materials are devices that are integrated into the body, the material used in implant construction is of great importance. In this article, some of the polymer materials used in implant making are analyzed thermo-mechanically and the ideal polymer material is tried to be determined. In the selection of the ideal material, the AHP method was used, and the results indicated that the most important criterion was Specific resistivity and the most important alternative was Polyimide[a]. The aim of the study was to contribute to the production of better neural implants in terms of thermo-mechanical properties. In future studies, it is predicted that higher quality results will be achieved by taking into account different materials, increasing the number of criteria and developing hybrid solution methods.

REFERENCES

ASLAN, Ş. & SEZGIN, M. (2017). Özel Sağlık Kuruluşlarında Müşteri Memnuniyeti ve Memnuniyeti Oluşturan Unsurların Araştırılması. *Sosyal ve Beşeri Bilimler Araştırmaları Dergisi, 1*(20),24-40.

AYDIN, Ö. (2009). Bulanik AHP ile Ankara İçin Hastane Yer Seçimi. *Dokuz Eylül Üniversitesi İktisadi İdari Bilimler Fakültesi Dergisi, 24*(2), 87-104.

DAS, S. S., CHAKRABORTI, P., BHOWMIK, C. & SINGH, R. (2019). *Decision-Making for Selection of Most Suitable Materials for Biomedical Applications.* In Book: Advances in Interdisciplinary Engineering (pp. 901-917). Springer, Singapore.

DOĞAN, N. Ö. & GENCAN, S. (2014). VZA/AHP Bütünleşik Yöntemi ile Performans Ölçümü: Ankara'daki Kamu Hastaneleri Üzerine Bir Uygulama. *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 16*(2), 88-112.

EMEÇ, Ş. & AKKAYA, G. (2018). Sağlık Sektöründe Zihinsel İş Yükü Değerlendirmesi ve Bir Uygulama. *Ergonomi, 1*(3),156-162. Doı: 10.33439/Ergonomi.470474

HAFEZALKOTOB, A. & HAFEZALKOTOB, A. (2015). Comprehensive MULTIMOORA Method with Target-Based Attributes and Integrated Significant Coefficients for Materials Selection in Biomedical Applications. Materials & Design, (87), 949-959.

HASSLER, C., BORETIUS, T. & STIEGLITZ, T. (2011). Polymers for Neural Implants. *Journal of Polymer Science Part B: Polymer Physics, 49*(1), 18-33.

İNCE, Ö., BEDİR, N. & EREN, T. (2016). Hastane Kuruluş Yeri Seçimi Probleminin AHP ile Modellenmesi: Tuzla İlçesi Uygulaması. *Gazi Sağlık Bilimleri Dergisi, 1*(3), 8-21.

KIDAK, L. B., ARSLAN, E. T. & BURMAOĞLU, S. (2016). Hastanın Sesi Duyuluyor Mu? Bir Devlet Hastanesinde Bulanık AHP ile Ağırlıklandırılmış Kalite Fonksiyon Göçerimi Uygulaması. *Journal of Alanya Faculty of Business/Alanya İşletme Fakültesi Dergisi, 8*(2),93-107

ÖNDER, G., AYBAS, M. & ÖNDER, E. (2014). Hemşirelerin Stres Seviyesine Etki Eden Faktörlerin Öncelik Sırasının Çok Kriterli Karar Verme Tekniği ile Belirlenmesi. *Optimum: Journal of Economics & Management Sciences/Ekonomi ve Yönetim Bilimleri Dergisi, 1*(1),21-35

ÖZÜDOĞRU, A. G. (2018). *Biyomedikal Cihaz Seçiminde Kriterlerin Önem Düzeylerinin Belirlenmesi*. Tıp Teknolojileri Kongresi, 8-10 Kasım 2018. Yer eksik Gazi Mağosa/ Kıbrıs.

RISTIĆ, M., MANIĆ, M., MIŠIĆ, D., KOSANOVIĆ, M. & MITKOVIĆ, M. (2017). Implant Material Selection Using Expert System. *Facta Universitatis, Series: Mechanical Engineering, 15*(1), 133-144.

SAATY, T. L. (1980) *The Analytic Hierarchy Process*. Mc Graw-Hill, New York.

TURAN, H. & TURAN, G. (2016). Hemşire Seçiminde Analitik Hiyerarşi Metodunun Uygulanması. *Sağlık Akademisyenleri Dergisi, 3*(1), 26-30.

UÇAR, U. Ü. & BALO, F. (2018). Determining of The Convenient Metal Dental İmplant Material in Terms of Strength Properties. *Organic Medicinal Chem International Journal, 6*(2),1-3.

UÇAR, U. Ü. & İŞLEYEN, S. K. (2019). Hareketli Hedefli-Heterojen Filolu İHA Rotalama Problemi İçin Yeni Bir Çözüm Yaklaşımı. *Politeknik Dergisi, 22*(4): 999-1016. DOI: 10.2339/politeknik.466393

VENKATESAN, P., MURALIDHARAN, C., MANAVALAN, R. & VALLIAPPAN, K. (2009). Selection of better method for the preparation of microspheres by applying Analytic Hierarchy Process. *Journal of Pharmaceutical Sciences and Research, 1*(3), 69.

VOUDRIAS, E. A. (2016). Technology selection for infectious medical waste treatment using the analytic hierarchy process. *Journal of the Air & Waste Management Association, 66*(7), 663-672.

URL.1.https://evrimagaci.org/gelecegin-elektrikle-calisan-beyinleri-noral-implantlarin-bugunu-ve-gelecegi-3246

URL.2.https://humanenhancementusingbrainchips.weebly.com/neural-implants.html

URL.3. http://www.saglikveyasamdergisi.com.tr/modern-tipta-yeni-ufuklar-beyin-pilleri.html

URL.4. https://dijitron.tv/hayatimizi-degistirecek-3-noral-implant/