Ministry of education and science of Ukraine
National Technical University of Ukraine
«Kyiv Polytechnic institute»
(NTUU "KPI")
Physics Engineering Faculty
Metals Physics Department

Warsaw University of Technology
Faculty of Materials Science and Engineering

ABSTRACT BOOKLET

9th International Students, Postgraduates and Young Scientists Conference

PERSPECTIVE TECHNOLOGIES ON THE BASE OF ADVANCED PHYSICAL MATERIALS SCIENCE RESEARCH AND COMPUTER MATERIALS DESIGN

April 14 – 15, 2016

Kyiv, Ukraine

Perspective technologies on the base of advanced physical materials science research and computer materials design. 9th International Students, Postgraduates and Young Scientists Conference. Abstract booklet. April 14 – 15, 2016, Kyiv, Ukraine – 205 p.

Conclusion and Desktop Publishing G.G. Lobachova, O.M. Gubina

Organizers:

Metals Physics Department NTUU "KPI"
Student Council and Council of Young Scientists specialty "Physical Materials science"

Conference Committee:

S.I. Sidorenko - Corresponding Member of NAS of Ukraine, Math Sci., supervisor of the Metals Physics Department, Physical Engineering Faculty of NTUU "KPI", Ukraine - Chairman;

Ie.V. Ivashchenko - Ph.D., Associate Professor, Acting Head of Metals Physics Department, Physical Engineering Faculty of NTUU "KPI", Ukraine - Vice-Chairman;

G.G. Lobachova - Ph.D., assistant, Chairman of the Council of Young Scientists of Metals Physics Department, Physical Engineering Faculty of NTUU "KPI", Ukraine - Vice-Chairman;

O. Neboga - Chairman of the Student Council of Physical materials science, Metals Physics Department, Physical Engineering Faculty of NTUU "KPI", Ukraine - Deputy Chairman

Members of the organizing committee:

K. Sikorski – professor, PhD, D.Sc., Warsaw University of Technology, Warsaw, Poland
O. Mikadze - D.Sc., professor, Ferdinand Tavadze Institute of Metallurgy and Materials Science, Tbilisi, Georgia;
I. Pundiene – PhD, Vilnius Gediminas Technical University, Vilnius, Lithuania
P.O. Topala – Balti A. Russo National University, Balti, Moldova
N.O. Balakhonova - PhD, senior lecturer, NTUU ―KPI‖, Kyiv, Ukraine
S.B. Vasiliev - senior engineer, NTUU ―KPI‖, Kyiv, Ukraine
N.A. Shapovalova - senior engineer, NTUU ―KPI‖, Kyiv, Ukraine
V. Syrovatko, S. Soldatenko, V. Boryshkevych, T. Berest, A. Mazuryk,
K. Melashenko, M.Fedorov – students, NTUU ―KPI‖, Kyiv, Ukraine

Scientific Secretary:

O. Hubina – student, NTUU ―KPI‖, Kyiv, Ukraine

СЕКЦІЯ 1

«Сучасні проблеми металевих матеріалів та нанотехнологій»

SECTION 1

«Modern problems of metal materials and nanotechnologies»

УДК 536.212.2

ON THE SELECTION SUITABLE METHODOLOGY FOR THE SIMULATION SHS REACTION IN MULTILAYER FOIL AS A LOCAL HEAT SOURCE FOR THE SOLDERING ELECTRONIC COMPONENTS

***Olifer L.A.*[*], *Monastyrsky G.*[**]**

National Technical University of Ukraine Kyiv Polytechnic Institute. Institute of Physics and Technology, Applied Physics department, Leonant@ukr.net
monastyrskygennady@gmail.com

Brief survey of the frequently used methodologies for the simulation self-propagating reactions in Ni/Al multilayer foils as a heat source for the soldering of electronic components are considering. It was shown that simplified SHS model is suitable for the fast estimation of heat propagation in joining components but quite unstable with respect to its parameters which have to be chosen with carefulness to fit experimental results.

Self-propagating exothermic reactions have been observed in multilayer foils: Al/Ni, Al/Ti, Ni/Si, Nb/Si etc. Once the reactions between the elements in layers is initiated by the external short pulse of energy the heat output is enough to sustain process until all components will intermix and new compound will appear. Speed of reaction propagation could be up to 30 m/sec[1] and maximum reaction temperature – above 1200 ^{o}C[1]. Such peculiarities of multilayered foils, along with small sizes (thickness is less than 1 mm) and possibility to sustain reaction without oxygen, provide a unique opportunity to use the foils as a local heat sources to melt solder layers and thereby join electronic components.

There is a thin edge in such technology, because one have to find such properties of foil (multilayer and pre-diffused layer thicknesses, number of layers) to make a strong bound and not to overheat electronic components. It is convenient that searching of needed properties is much easier to do using a computer simulating program. Thus the goal of this research is to develop computer simulation model with legitimate and easiest way of describing multilayer foil as a heat source.

There are different methods of describing and simulating SHS in multilayer foils. Those methods could be divided in 3 categories: 1) Very detail simulation is

based on mass and heat transfer equations [2]. Such approach gives detailed profile of reaction front including phase and temperature distribution inside of a foil and could be done in 2D or 3D; initial parameters are – physical parameters of a foil. 2) Simplified heat and diffusion model [3] allows simulating detailed temperature distribution but not the phases ones. Model has to be quasi-1D or in higher dimensions. Also, using this approach an oscillatory reaction mode could be simulated. 3) Simulating profile of heat output only is the way to make simplest model[4]. To describe heat output usually DSC curves are used. Model could be created in any dimension.

In fact, for the simulation of heat flow through electronic components and solder we don‘t need to know exact phases content inside the foils or to simulate oscillatory mode of SHS – it‘s enough to know only the heat output produced by SHS reaction. Simulation was made using FEM. To describe heat output we used generalized extreme value distribution (GEVd) for the heat inside the sample. Simulation of SHS propagation as a moving DEVd with constant velocity gave a plausible results (Fig. 1).

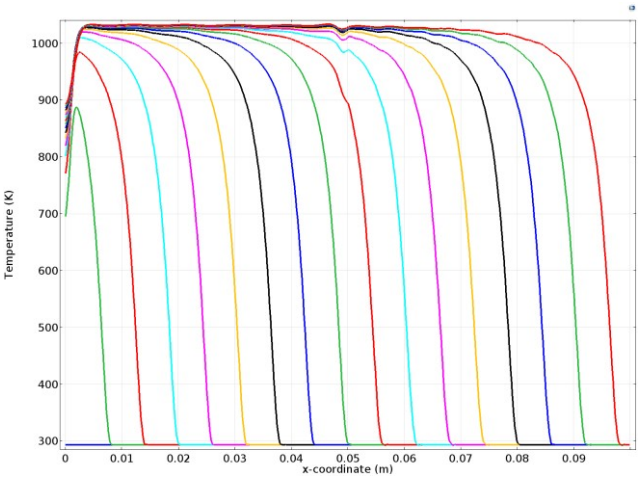

Fig. 1. Simulated temperature distributions in the foil at different times. Time interval: 1 msec. Speed of reaction: 6 m/sec

It was shown that such approach is easy-to-use however is sensitive to choosing the distribution parameters. Thus further development have to be done to provide better fitting with an experimental results.

References

1. Handbook of Thin Film Process Technology / T. P. Weihs (Institute of Physics, UK, 1998)
2. Modeling of the self-propagating reactions of nickel and aluminum multilayered foils / I. E. Gunduz, K. Fadenberger, M. Kokonou, C. Rebholz, C. C. Doumanidis, and T. Ando // Journal of Applied Physics #105, 074903 (2009)
3. O. Ostashevsky, T. Zaporozhets // Metallofizika i Noveishie Tekhnologii, #3 (2012)
4. Joining of stainless-steel specimens with nanostructured Al/Ni foils / J. Wang, E. Besnoin, A. Duckham, S. J. Spey, M. E. Reiss, O. M. Knio, and T. P. Weihs // Journal of Applied Physics #95, 248 (2004)