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Final Report

on Deliverable

MAT-1.2.1-T006-D001 - PPPT Pilot Material Handbook of Alumina 2016

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| **Project Leader** | *Michael Rieth* | | |
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| **Executive Summary** |
| The task is: Create pilot Material Handbook structure and indicative content for a Functional Material . The purpose of the work is to create and populate material data sheets for functional materials used in DEMO. Functional materials are different from the structural materials. The strengths properties have secondary importance for the designers, but some physical properties such as electrical resistivity, electrical conductivity, permittivity, dielectric strengths, loss of tangent (dissipation factor), transmission, absorption and reflectance are the more relevant properties. MTA EK collected all reports from the WPMAT FM group and a lot of information from the open literature. These information have been used for the first draft of functional materials MPH. MTA EK fulfilled the tasks, edited the MPH including all available data on mechanical and physical properties of alumina. In contrary of the metallic materials the information are not always in number format (can be described by fitting relevant functions). |

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| **Comments** (shortcomings, deviations, etc.) |
| Difficulty that the FM group has no experience in the MPH elaboration, and the MTA EK has no experience with the functional materials. In the future periodical meetings (VC and personal) required to finalize the alumina MPH and extend the FM MPH with chapters on other FM materials. |

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**Abbreviations**

|  |  |
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| *FM* | *Functional Materials* |
| *DEMO* | *Demonstration Fusion Reactor* |
| *MPH* | *Material Properties Handbook* |
| *MTA EK* | *Energy Reserarch Centre of the Hungarian Academy of Sciences* |
| *VC* | *Video Conference* |

# Short Introduction and Objectives of Work

MTA EK in co-operation with KIT elaborated the EUROFER97 MPH. Using the experience in editing MPH a further task is to elaborate a similar MPH pilot chapter on alumina. This draft MPH chapter will be the base of the FM MPH, providing format and sample for the content of other FM materials. MPH is a summary of the research work performed within the FM group, and the channel to provide the research results to the DEMO designers.

# Description of Work

MTA EK connected WPMAT sub-project team in Functional Materials (FM), including attendance at their PMM and additional key meetings in agreement with EDDI project leader. MTA EK representative kept the FM group updated on EDDI developments, including: evolution of database templates, Materials Property Handbook. MTA EK participated on the June PMM meeting at Tartu, and presented the FM database and FM MPH, required contribution of the participants. At middle of August 2016 the database, the templates and the draft MPH have been sent to the FM participants asking for assistance in the development of the them. Presently unfortunately the co-operation with the FM group is not so active as it was with KIT during the development of the EUROFER MPH.

The Functional Materials Alumina pilot MPH chapter is elaborated in two parts. The FM MPH pilot chapter development has two purposes:

* Collect available information on alumina for the designers.
* Provide format for the further FM materials chapters

In the first part of the MPH all properties are collected from catalogues, handbooks, standards, and from the open literature. This part describes the properties of market quality alumina generally in the function of purity and testing temperature. These parts gave some preliminary information on the alumina properties not included into the WPMAT program, but may be useful for the designers. The collection of the property sheets is wide, all physical and mechanical properties may interesting for designers are considered and included. Some mechanical and thermal properties considered are the same as at the structural materials (thermal expansion, hardness, density), but the majority of them are typical only for the functional materials. The list of properties included into the functional materials MPH are as it follows:

[1. General information](#_Toc458712959)

[2. Chemical composition](#_Toc458712960)

[3. Density](#_Toc458712961)

[4. Grain size](#_Toc458712962)

[5. Maximum use temperature](#_Toc458712963)

[6. Melting point](#_Toc458712964)

[7. Porosity](#_Toc458712965)

[8. Absorption](#_Toc458712967)

[9. Relative permittivity](#_Toc458712968)

[10. Dielectric Loss or Loss of tangent](#_Toc458712969)

[11. Dielectric Strength](#_Toc458712970)

[12. Electrical resistivity](#_Toc458712974)

[13. Permittivity](#_Toc458712975)

[14. Reflectance](#_Toc458712976)

[15. Specific heat](#_Toc458712977)

[16. Thermal conductivity](#_Toc458712978)

[17. Thermal diffusivity](#_Toc458712979)

[18. Linear thermal expansion](#_Toc458712980)

[19. Thermal schock resistance](#_Toc458712981)

[20. Bulk modulus](#_Toc458712982)

[21. Compressive strength](#_Toc458712983)

[22. Young’s modulus](#_Toc458712984)

[23. Flexural strength](#_Toc458712985)

[24. Fracture toughness](#_Toc458712986)

[25. Hardness](#_Toc458712987)

[26. Poisson’s ratio3](#_Toc458712988)

[27. Shear modulus](#_Toc458712989)

The second part of the FM MPH is specific for the WPMAT research results. The FM group developing some important optical and dielectrical properties of alumina. This work is summarized in the second part of the MPH based on the relevant WPMAT reports. The alumina described in this part of the document is under development for use in DEMO. Presently only the identification, production method, density and the dielectric properties are studied. These fine grain materials have enhanced dielectric properties, made from high purity Al2O3. In the MPH we tried to summarize the newly developed properties of it in user friendly format.

# Conclusion

Pilot chapter of the MPH is elaborated and provided for discussion and for contributions to the FM research subgroup. MTA EK participated on all FM subgroup meetings and provided information on the database and MPH. Enhanced co-operation with the FM subgroup and other PPPT project teams, including diagnostics and control and heating and current drive projects is required to finish the MPH chapter on Alumina and include the other functional materials.

The reference to the MPH pilot chapter had been created and uploaded to the IDM: EFDA\_D\_2MWBCU.([IDM Root](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=29PSK8)/[EUROfusion](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2L6TNJ" \o "EUROfusion)/[PPPT - Power Plant Physics and Technology](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2MF7QH)/[11 MAT-Materials](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2MDXWC)/[a. Design Data Integration](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2MEFBA)/[WBS1.2 Material Database & Handbook](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2KWTBB)/[Public](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2MFPBC)/[Data Deposit](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2MD4CY)/[Functional Materials](https://idm.euro-fusion.org/IDM/Pages/DocumentSystem.aspx?uid=2M8N3B)).

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1. One *Deliverable Report* shall be submitted for each deliverable e.g. Study Report, Commissioning Report, Final Assessment Report, Technical Acceptance Report, Procurement Report, etc. [↑](#footnote-ref-1)