IMPROVING TEMPERATURE SENSITIVITY OF THE MECHANICAL STRENGTH OF FOAMED PROPELLANTS

J. Böhnlein-Mauß, H. Kröber, A. Pfatteicher, G. Kronis

Fraunhofer Institut für Chemische Technologie ICT, 76327 Pfinztal

jutta.boehnlein-mauss@ict.fraunhofer.de

Abstract

Mechanical and burning characteristics of foamed propellants used as combustible cartridges have to be well composed in order to provide their proper function in a weapon. A basic problem, which emerges when mechanical stability at the shot is unsufficient, is a phenomenon called gas-slipping. Gas-slipping occurs when a cartrigde cannot withstand the boost caused by the igniting-process. In this case gas gets ("slips") from the cartridge chamber into the gun barrel before the projectile arrives. This effect causes undesirable impacts on a weapon, like low projectile velocities and low reproducibility of shot-series. Especially the temperature behaviour of the mechanical properties of foamed propellants plays an important role in these considerations.

Experimental

The measurement of the mechanical properties were carried out by compressing defined foamed propellant segments in a one dimensional pressure test. Basic mechanical parameters as $stress_{max}$, E-modulus and $compression_{max}$ were determined via software.

The foamed propellants consist of three main components:

a) explosive filler
b) energetic binder
c) processing aids (catalysts, foam stabilizers,…)

Foamed charges can be produced easily by the reaction injection moulding process. Type, mode and proportion of all components have naturally a great influence on the mechanical properties. Fig.1 shows the measured E-modulus of foamed propellant segments in the temperature range between -40°C till +50 °C.

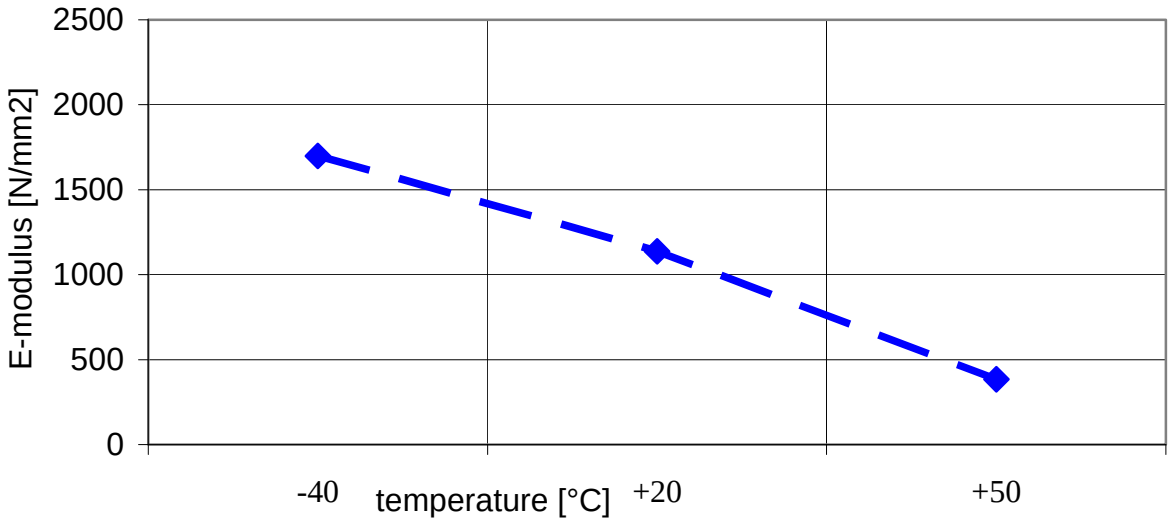

Fig. 1: Temperature sensitivity of the mechanical strength of the original formulation of foamed propellant

The observed decrease of the E-modulus with increasing temperature is not suitable for weapon applications. Therefore a lot of small modifications in the original formulation, e.g. enhancing the filler content or the fraction of the fine filler or the R-value or the densiy, has been performed to improve its temperature sensitivity. Nevertheless the temperature sensitivity of the mechanical strength of the modified foamed propellants is unchanged. This result shows that the energetic binder of the foamed propellants plays an important role concerning the mechanical behaviour of foamed propellants. Therefore other binder components, especially other GAP-types are chosen and mixed in the original formulation of the foamed propellant. Fig. 2 shows the results of the one dimensional pressure test of foamed propellant segments. Using this new energetic binder system a significant improvement of the temperature sensitivity of the mechanical strength of foamed propellants can be achieved.

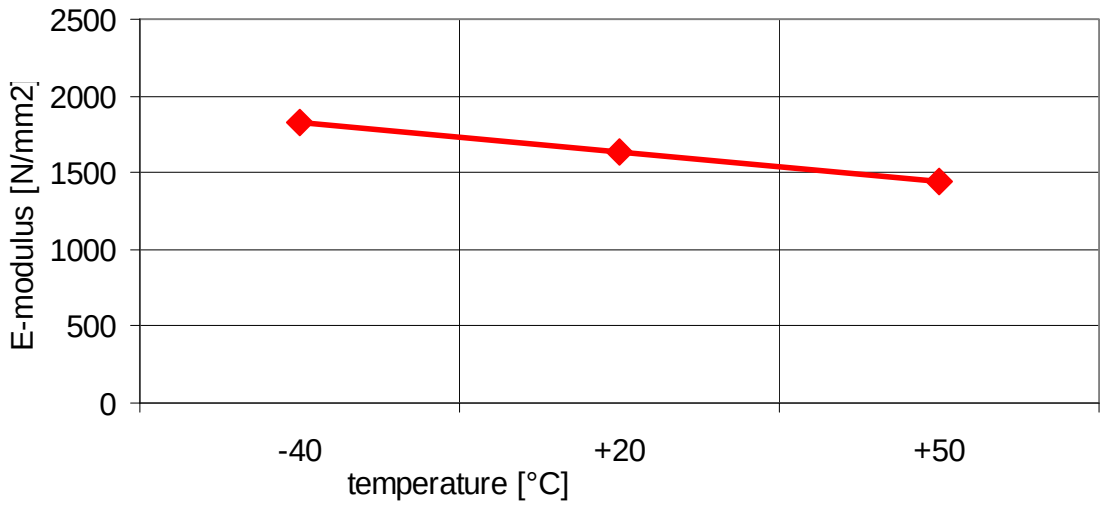

Fig. 2: Temperature sensitivity of the mechanical strength of the binder modified formulation of foamed propellant

Summary

Mechanical characteristics of foamed propellants used as combustible cartridges have to be well composed in order to provide their proper function in a weapon. Especially the temperature behaviour of the mechanical properties of foamed propellants plays an important role in this considerations. It is shown that by using a modified energetic binder system a significant improvement of the temperature sensitivity of the mechanical strength of foamed propellants can be achieved.

Literature

[1] J. Böhnlein-Mauss, F. Schedlbauer, U. Steffens, I. Reuter, Erprobung verbrennbarer Hülsen für das Kaliber 30 mm, 1. Fachtagung: Innenballistik der Rohrwaffen, XVI, 1-10 BICT, Swisttal-Heimerzheim, (1996)

[2] J. Schwörer, J. Böhnlein-Mauss, Untersuchung des Einflusses von Verfahrensparametern auf die Schäumungsstruktur von gefüllten Kunststoffen, Bericht 3/96, Fraunhofer Institut für Chemische Technologie, (1996)

[3] A. Messmer, F. Schedlbauer, Konzeption einer Herstellungsanlage für geschäumte polymergebundene Treibladungen, Bericht 12/97, Fraunhofer Institut für Chemische Technologie, (1997)

[4] F. Schedlbauer, A. Messmer, U. Steffens, I. Reuter, "Combustible Cases for RMK 30", 29th International Annual Conference of ICT, Karlsruhe, Germany, P103, (1998)

[5] T. Fischer, A. Messmer, G. Langer, Geschäumte polymergebundene Treibladungen, Wehrtechnisches Symposium: Innenballistik der Rohrwaffen, BAkWVT Mannheim, (1999)

[6] T. Fischer, W. Koppenhöfer, G. Langer, M. Weindel, Modellierung von Abbrandphänomenen bei porösen Ladungen, 30th International Annual Conference of ICT, Karlsruhe, Federal Republic of Germany, P98, (1999)

[7] A. Messmer, A. Pfatteicher, K. Schmid, W. Kuglstatter, "Foamed Propellants with Energetic Binders", 31st International Annual Conference of ICT, Karlsruhe, Germany, P111, (2000)

[8] T. Fischer, A. Messmer, Burning Characteristics of foamed polymer bonded propellants, 19th International Symposium on Ballistics, Interlaken, Switzerland, (2001)

[9] A. Messmer, T. Fischer, Foamed propellants with energetic binders: Burning characteristics, 32nd International Annual Conference of ICT, Karlsruhe, Germany, P144, (2001)

[10] T. Fischer, A. Messmer, S. Kelzenberg, N. Eisenreich, G. Langer, Abbrandverhalten poröser TLP: Experimente, Modell und innenballistische Simulation, Innenballistik der Rohrwaffen, Wehrtechnisches Symposium 24, 11.1-11.30, BAkWVT-Mannheim, (2001)

[11] H. Krause, A. Messmer, Foamed Propellants with Energetic Binders, Insensitive Munitions and Energetic Materials Technology Symposium, Tome 1, 293-298, (2001)

[12] J. Böhnlein-Mauss, A. Eberhardt, Foamed Propellants, Propellants, Explosives, Pyrotechnics 27, pp. 156 – 160, (2002)

[13] T. Fischer, J. Böhnlein-Mauss, A. Eberhardt, N. Eisenreich, Burning characteristiics of foamed polymer bonded propellants, 33rd International Annual Conference of ICT, Karlsruhe, Germany, P139 (2002)

[14] J. Böhnlein-Mauss, A. Eberhardt, Geschäumte Treibladungen: Von der Idee zum Formkörper, Wehrtechnisches Symposium: Innenballistik der Rohrwaffen, BAkWVT Mannheim, (2003)

[15] T. Fischer, J. Böhnlein-Mauss, Abbrandverhalten geschäumter Treibladungsformkörper: Experimente und Simulation, Wehrtechnisches Symposium: Innenballistik der Rohrwaffen, BAkWVT Mannheim, (2003)

[16] J. Böhnlein-Mauss, C. Attig, Foamed Propellants; Insights in the Foaming Process, 34th International Annual Conference of ICT, Karlsruhe, Germany, P159, (2003)

[17] T. Fischer, J. Böhnlein-Mauss, A. Eberhardt, Burning Behaviour of Foamed Propellants: Burning Interruption Experiments, 34th International Annual Conference of ICT, Karlsruhe, Germany, P165, (2003)

[18] J. Böhnlein-Mauss, A. Pfatteicher, The Influence of Spherical RDX on the Properties of Foamed Propellants, 35th International Annual Conference of ICT, Karlsruhe, Germany, P 73, (2004)

[19] J. Böhnlein-Mauss, B. Scheidt, A. König, A. Pfatteicher, H. Popp, H. Kröber, Foamed Propellants, 36th International Annual Conference of ICT, Karlsruhe, Germany, P172, (2005)

[20] T. Fischer, J. Böhnlein-Mauss, Abbrandcharakterisierung geschäumter Ladungen: Besonderheiten in Experiment und Simulation, Wehrtechnisches Symposium Ballistik in Forschung und Technologie, BAkWVT, Berlin, (2005)

[21] J. Böhnlein-Mauss, Von der Idee bis zur Serienreife, Symposium Wirkung und Schutz, BAkWVT, Berlin, (2006)

[22] J. Böhnlein-Mauss, S. Panic, A. Pfatteicher, B. Scheidt, G. Kronis, Mechanical properties of Foamed Propellants, 37th International Annual Conference of ICT, Karlsruhe, Germany, P158, (2006)

[23] J. Böhnlein-Mauss, H. Kröber, B. Scheidt, Processing and Manufacturing of Foamed Propellants, 38th International Annual Conference of ICT, Karlsruhe, Germany, P104, (2007)

[24] J. Böhnlein-Mauss, H. Kröber, Geschäumte Treibladungsformkörper, Ballistik in Forschung und Technologie 2007, BAkWVT Mannheim, (2007)