Dynamic Mechanical Analysis of Plastic Bonded Explosives

Mary S. Campbell
Los Alamos National Laboratory
bmcampbell@newmexico.com
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Aging processes that change the mechanical properties of the binder of plastic bonded explosives (PBX) could have a significant effect on the composite mechanical properties. It is essential to understand how the binder ages; however, it is more realistic to test the change of mechanical properties of aging PBX. Because PBX's and Mocks have only a small amount of binder, a method must be used that is very sensitive to the mechanical properties. Dynamic Mechanical Analysis can measure the glass transition even when the polymer has a reduced amorphous fraction, as is the case for partially crystallized Kel-F 800. The T_g is taken as the maximum of the Tan delta. We have studied, PBX 9501, aged in a magazine, a 36-day virtually aged PBX 9501, a stockpile aged PBX 9502, and their Mocks, 900-21 and 900-24. Dynamic mechanical (DMA) tests on polymers are used to evaluate the bulk modulus or stiffness of a material over a broad range of temperature and to identify the glass transition temperature (T_g) of the binder. PBX 9501, is composed of 94.9-wt% HMX, 2.5-wt% Estane 5703, and 2.5-wt% nitroplasticizer [50/50 eutectic of bis(dinitropropyl)acetal/formal] and 0.1-wt% Irganox 1010. PBX 9502 is composed of 95-wt% TATB and 5-wt% binder. The binder, Kel-F 800, is a copolymer of chlorotrifluoroethylene and vinylidene fluoride. Previous studies have shown an increase in the crystallinity of the polymer on aging (1).

The effects of aging on the modulus are different for the binders of two explosives in the stockpile, PBX 9501 and PBX 9502. Accelerated aging of the Estane under a humid air atmosphere reduces the average chain length, resulting in a slightly lower T_g (2). Kel-F 800 has a T_g slightly above ambient, which can slowly crystallize. As it crystallizes the storage modulus increases (1, 3).

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2. D. A. Garcia and M. S. Campbell, Los Alamos National Laboratory report LA-13621-MS (1999)
3. R. H. Boyd, *Polym*er, 1985, 26, 323