

Impact of NBS/NIST on Understanding of Amorphous Polymers:

From Rubber, Melt, Glass and Beyond

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Amorphous polymers have been used for millennia, and the National Bureau of Standards/National Institute of Standards and Technology has had a major role in the both the development of these materials and in establishing fundamental physics of them over the past century. From the present speaker's tenure at NBS/NIST and then after moving to academia, it has become clear that the ability to make progress in our understanding of these amorphous materials depends on being able to "stand on the shoulders" of a giant of an institution. So, in my talk I will discuss briefly the history of rubber, polymer melts, and polymer glasses from an NBS/NIST view. Then, with a set of vignettes, I will attempt to illustrate how the work in these labs was key to developments in the fields. McPherson, Wood, Bekkedahl, and Stiehler are important names in the development of rubber from WWI and through the 1950s and 1960s. The works of these people formed the foundation for my own research in rubber. In the case of polymer melts, not only was the rheology group lead by Marvin a major actor in the field, but in that group, the work by Bernstein, Kearsley and Zapas lead to the BKZ theory of a 'perfect elastic fluid' in 1963 that was a foundational development in the field of rheology. It strongly influenced my own development as a rheologist. Finally, NBS/NIST had an influence on our understanding of glasses, not only through the many works from DiMarzio, but also through the 'surprise' transfer of knowledge that made possible the fundamental characterization of glassy kinetics as measured in France in the 1950s and 1960s. In this instance, A.J. Kovacs, traced the dilatometers he built to the instrumentation developed by Bekkedahl in his work with rubber. The understanding that comes from the mixing of the different sets of knowledge and insights lead to a truly novel set of experiments on a 20 million year old amber, a fossil organic glass. Without the prior knowledge these could not even have been contemplated, yet the results demand a reassessment of the paradigms of glass formation and glass properties that are currently in use.