Materials Technologies associated with Pittsburgh, which we colloquially refer to as "The Burgh"

In this brief review, I owe a considerable debt to my colleague David Hounshell, who has made a study of the history of materials one of his main topics of research.

Until the railroad arrived in Pittsburgh in 1854, the 'Burgh was isolated from the east coast but connected to the West by the Ohio River, which in turn connected to the Mississippi. Therefore its early industrial history has to do with supply for the West. For example, it is thought that Lewis & Clark had their boat built here in Pittsburgh. Note that 2016 is the second centenary of the founding of the city. Continuing with boats, steamboat construction started in 1811 and rather soon the problem of boiler explosions appeared. The profession of failure analysis got going at about the same time, led by AD Bache and leading to the first Federal regulations (on boilers) in 1838. Anyway, about 1/3 of the tonnage of boats for western navigation were built in Pgh between 1811 and 1870.

One of the earliest man-made materials was bar iron, which was used in boats and furniture, both as straps and nails. Puddling technique was used, also charcoal furnaces.

With so much fabrication, there was a strong demand for tools with steel blades, which drove the development of the tool steel industry, after an initial phase of importing such steels from Sheffield. Naturally this shifted from importing steel to importing people. However, the pig iron and wrought iron in western PA had different compositions from what the Sheffield "masters" were used to and so there were problems. Not until the 1850s were there successful tool steel makers in Pgh.

As with iron and the early specialty steels, trade with the West drove the development of the glass industry, which started back in the 18th century and found its ultimate expression in Pittsburgh Plate & Glass, or PPG. Glass research became much more serious in the 1st world war with joint research between several companies and the Bureau of Mines. Which latter, BTW, had one of its original laboratories on the CMU campus, now the Heinz School of Public Administration.

Likewise, the textile industry was a major activity in Pittsburgh, once again for supplying exploration etc. in the West. The famous Andrew Carnegie enters the picture as a bobbin boy in a textile mill, shortly after his family arrived. Later he was a personal assistant and telegrapher to a PRR executive, which gave him access to crucial information about business finance. As an executive, he took full advantage of his position in trading stocks, which of course would be prosecuted as "insider graining" these days. He got involved in the steel industry even while working for the PRR and his companies supplied much bridge steel. Above all, he knew the results of trials comparing iron against steel rails, which allowed him to know that there was going to be an enormous demand for the latter. The Edgar Thomson Works started construction in 1872 on the banks of the Monongahela about 6 miles from here, in anticipation of this demand, which was quickly realized. Over the decades, there was an almost linear increase in the size of rail as the railroads became prepared to pay more per rail in order to obtain longer life. In the end, Andrew Carnegie sold his company, which had done more than any other to develop low cost, mass produced steel, and became one of the richest men in the world at the time. He then dedicated a lot of effort to giving away almost all of his money.

The other major materials story in Pittsburgh is that of aluminum/aluminium. This started with Charles Hall, one of the inventors of the electrolytic extraction process, which produced the paradigm shift (if you like) of aluminum from almost a precious metal to a commodity metal,

albeit expensive compared to steel. Hall came to Pittsburgh looking for venture capital and succeeded in partnering with Hun, Clapp and Davis. The Hunt family is still here and benefactors of CMU. The original "Hall Reduction Co." building is located not far from here in the Strip District. The success of the process caused the company to move out to New Kensington, which is a few miles northeast up the Allegheny river. In the 1980s, they built a new lab on a greenfield site, some miles south of the original site. However, we have to mention Andrew Mellon (as in Carnegie Mellon University) who was a major venture capitalist and developed of companies. The magnificent Mellon Institute with its monolithic stone columns was built as the corporate research lab for his conglomerate of companies, e.g. Gulf Oil, e.g. Koppers.

I have tried to convey in this short talk, the rich history of materials-based industry in Pittsburgh, as well as the many distinguished individuals who have contributed to our understanding of recrystallization and grain growth.

People in Rex & GG in Pittsburgh

Robert Mehl – JMAK, introduced quantitative metallurgy

Bill Hu, USS Bain Lab., subgrain coalescence, e.g.; measurement of twins, Hu & Smith (check in Pande's paper, Met Trans 1990 **21A** 2891)

Fred Rhines, started at Carnegie Tech., moved to Florida, started their materials science program. Famous for coining the term "microstructology", which, sadly, has fallen

Bill Mullins, von Neumann & Mullins, 1956 paper, plus many others; most famous for his analysis, with Sekerka, of interfacial instability with application to solidification

Bob Sekerka, also started at the Westinghouse Lab.; in addition to Mullins-Sekerka, contributed substantially to the development of the phase field method

Lloyd Bauer, MSE, Carnegie Mellon University; famous for his experiments to measure grain boundary mobility via manufactured bi-crystals, i.e. curvature driving force. Russians developed this in parallel and then continued at Aachen.

Brent Adams, at CMU 1994-2000 (approx.); inventor of OIM, many mathematical analyses of microstructure and mechanical response, e.g. GND measurements

Greg Rohrer, CMU; development of GBCD approach, anti-correlation between energies of grain boundaries and populations.