more compatible with clinically accepted methods of cancer imaging[10]. Additionally, Gao and colleagues suggest the preliminary animal studies showed negligible toxicities with regard to the tertiary-amine-based polymeric micelles. However, the literature is rife with many toxic tertiary amino polycations that have been known to induce cell necrosis[11]. More systemic and long-term toxicological studies are required before the translation of this powerful nanoprobe to clinical adaptation. Despite the fact that much work remains to be done, the extremely high sensitivity makes these nanoprobes promising candidates for clinical tumour diagnosis. The purpose of this research, namely proof-of-concept for exploiting several general commonalities between tumours, has been clearly demonstrated. In this regard, ultra-pH-sensitive nanoprobes may have a bright future in oncodiagnostics. ❐

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MATERIAL WITNESS

NO SUBSTITUTE

Materials scientists are well accustomed to basing their materials choices on a careful balancing of performance criteria, for example trading off toughness, hardness and cost. It's less common to have to base those choices on geopolitical criteria. But such stark realities are not so unfamiliar, perhaps most notably in recent years in concerns about the Chinese near-monopoly on rare-earth elements, and continuing fluctuations in the availability of tantalum for semiconductor electronics due to political instability in the Congo region. When abrupt materials shortages have occurred, substitutes have sometimes been found. The isolation of southeast Asian colonial rubber plantations during the Second World War prompted seminal work in Europe and the USA on synthetic rubber. And when civil war in Zaire in the 1970s impaired the supply of cobalt, an important component of magnets, cobalt-free designs were developed.

It might be tempting to suppose, then, that whenever shortages of materials components occur, alternatives will soon emerge. That would be complacent, according to a recent report by Graedel and colleagues[1]. They have considered as many as possible of the major uses for 62 different metals and metalloids, and whether there are known alternatives that could substitute for them if supplies become scarce. In many cases there are, but for 12 of the elements examined, substitutes are either inadequate or non-existent at present. What's more, none of the 62 elements have good replacements for all of their major uses.

Although scarcity of important materials is an ancient issue — one famous, although controversial, case was the British navy's wood shortage in the seventeenth and eighteenth centuries due to deforestation — it is rendered more critical today by several factors. The market for materials is more global, and so more susceptible to international affairs. And the complexity of materials usage has increased. In engineering alloys, for example, a steady enhancement of performance by an accumulation of ingredients means that the formulations of the superalloys used for high-temperature applications may include a dozen or more elements. Environmental considerations now play a much bigger role in resource exploitation, even while the rapid growth of some emerging economies has increased the demand on non-renewable sources.

It's for such reasons that in 2006 the US National Research Council performed an audit of economically important materials, developing a framework for assessing their 'criticality' on the basis of both the importance of their uses and the security of their sources[2]. Several metals, including rhodium, manganese, platinum and niobium, were deemed by these criteria to be 'at risk'. Graedel *et al.* seek to extend that work, concurring, for example, with the assessment for the former two metals while offering more reassurance for the latter.

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What are we to do? Simply recognizing the problem (and abandoning a naive faith in the ability of markets to produce substitutes) is a start. A systematic enumeration of the risks — which applications of 'at risk' materials would be hit first, for example? — would provide a framework for assigning priorities. But arguably this problem might compel a realignment of some of the materials community's research objectives: instead of obsessing over improved performance, more attention might be given to maintaining current performance by other means. ❐

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